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# INSTITUTIONAL SUPPORT & STRENGTHENING PROGRAM

## *NATIONAL STRATEGIC WASTEWATER MASTER PLAN FINAL REPORT*



October 2013 (Updated February 2014)

This report was produced for review by the United States Agency for International Development (USAID). It was prepared by International Resources Group (IRG) for the Institutional Support & Strengthening Program (ISSP).

# INSTITUTIONAL SUPPORT AND STRENGTHENING PROGRAM (ISSP)

## NATIONAL STRATEGIC WASTEWATER MASTER PLAN FINAL DRAFT REPORT

October 2013 (Updated February 2014)

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# ACRONYMS

AGTP	Ain Ghazal pre-treatment plant
ASEZA	Aqaba Special Economic Zone Authority
AWC	Aqaba Water Company
BOD	Biological Oxygen Demand
DN	Nominal Diameter
DOS	Department of Statistics
EZPS	East Zarqa Pumping Station
GIS	Geographic Information System
HCPS	Hitteen Camp Pumping Station
ISSP	Institutional Support and Strengthening Program
JD	Jordanian Dinar
JPM	Jordan Phosphate Mines
JS	Jordanian Standards
Kg/d	Kilogram Per Day
Km	Kilometer
Km <sup>2</sup>	Square Kilometer
lpcd	Liters Per Capita Per Day
m <sup>3</sup> /d	Cubic Meter Per Day
m <sup>3</sup> /hr	Cubic Meter Per Hour
MCC	Millennium Challenge Corporation
MJOD	Million Jordanian Dinars
mm	Millimeter
MWI	Ministry of Water and Irrigation

PLC	Programmable Logic Controller
PS	Pumping Station
SATP	South Amman Wastewater Treatment Plant
SCADA	Supervisory Control and Data Acquisition
TP	Treatment Plant
USAID	United States Agency for International Development
USTDA	The United States Trade and Development Agency
WAJ	Water Authority of Jordan
WIP	USAID funded Water and Wastewater Infrastructure Project
WSP	Wastewater Stabilization Ponds
WSTP	Wadi Es-Seer Wastewater Treatment
WW	Wastewater
WWTP	Wastewater Treatment Plant
WZPS	West Zarqa Pumping Station

# EXECUTIVE SUMMARY

This report presents the national Strategic Wastewater Master Plan for Jordan which was prepared at the request of H.E the Minister of Water and Irrigation by the USAID/Jordan Institutional Support and Strengthening Program (ISSP). The purpose of this plan is to help the Ministry in determining investment priorities in wastewater services across Jordan through 2035. The country has 27 operating wastewater facilities owned by the Water Authority of Jordan (WAJ) and a tremendous number of studies which have been done on wastewater treatment and reuse for different governorates, cities and communities of all sizes in Jordan. In spite of this, no such strategic master plan has ever been prepared on the national level based on national priorities and criteria which can be applied across all governorates and localities.

The ISSP national Strategic Wastewater Master Plan was developed based on the following factors: planning horizon, number of people to be served, amount of wastewater to be treated, level of treatment required, environmental hot spots, and a needs assessment in order to determine investment costs.

Driven by the Jordan Water Strategy which calls for all major cities and small towns in Jordan to be provided with adequate wastewater collection and treatment facilities by the year 2022, it was first necessary to agree on the size of the small town. For the purpose of this study, it was defined as a community of 5,000 inhabitants thus setting the lower population limit for provision of wastewater service. According to this criterion, a detailed population study, including population forecasts to the year 2035 planning horizon, had to be made for the nation as a whole but analyzed at the specific governorate level, broken down into individual localities within each governorate in order to accommodate the different growth rates projected for each area. The governorate-level population growth rate information was provided by the Department of Statistics (DOS) and was applied to all the localities within a governorate to ensure planning was tied to the different growth rates for the various governorates (i.e. Aqaba governorate average annual growth rate of 2.7% while 1.8% for Madaba).

The following table provides an overview of the population profile in Jordan:

<b>Nationwide Population Overview</b>		
<b>2012 POPULATION DISTRIBUTION</b>		
<b>Localities</b>	<b>No. of Localities All 12 Governorates</b>	<b>No. of People</b>
Total No. of Localities	1,042	6,338,000
More than 5,000 People	173	5,461,037 (86%)
Less than 5,000 People	869	908,597 (14%)
<b>POPULATION GROWTH PROJECTIONS</b>		
<b>Year</b>	<b>Total Population All 12 Governorates</b>	<b>%Increase – from 2012</b>
2012	6,338,000 people	Base Year
2025	8,507,131 people	33% (2,169,131 people)
2035	9,902,325 people	55% (3,564,325 people)

The above table shows that 86% of the nation’s population will be covered if the 173 localities with more than 5,000 people are served. This leaves only about 14% of the population residing in communities with less than 5,000 people who will be excluded from the wastewater collection systems. A breakdown of the population figures in relation to localities and their access to wastewater facilities is shown in the next table.

The Strategic Wastewater Master Plan’s objective was thus to arrive at an investment plan for wastewater collection and treatment systems throughout the country that takes into consideration national priorities for such investment through a specific planning horizon. As discussed above it was based first on the population levels of localities. The planning was then compounded by an examination of the existing plants and sewer networks which are of different ages and at different levels of loading to account for current capacities to service the target populations. In addition, agglomerations are growing to form sizable communities which also require future wastewater collection and treatment facilities.

### Nationwide Existing Wastewater Collection & Treatment Status by Governorate

Governorate	Totals by Governorate		Localities larger than 5,000 people		Population Served with Wastewater Collection and Treatment Systems			
	No. of Localities	Total Govern. Population (2012)	No. of Localities larger than 5,000 people	Total Population in Localities larger than 5,000 people	No. of Localities Served	Total Population Number Served	% of Total Governorate Population Served (2012)	% of Total Population Residing in Localities larger than 5,000 people
<b>Amman</b>	157	2,473,400	32	2,345,764	25	2,080,112	84%	89%
<b>Balqa</b>	80	428,000	17	328,784	11	184,000	43%	56%
<b>Madaba</b>	73	159,700	6	119,780	1	51,900	32%	43%
<b>Zarqa</b>	57	951,800	7	911,158	4	685,296	72%	75%
<b>Irbid</b>	137	1,137,100	54	981,378	12	594,404	52%	61%
<b>Mafraq</b>	172	300,300	12	139,102	1	24,000	8%	17%
<b>Jerash</b>	55	191,700	10	131,808	16	113,031	69%	86%
<b>Ajloun</b>	55	146,900	10	117,172	4	61,700	42%	53%
<b>Karak</b>	115	249,100	12	120,825	7	51,000	20%	42%
<b>Tafilah</b>	41	89,400	6	68,452	3	27,720	31%	40%
<b>Ma'an</b>	71	121,400	5	72,703	6	46,820	39%	64%
<b>Aqaba</b>	29	139,200	2	119,210	1	100,418	72%	84%
<b>Totals</b>	<b>1,042</b>	<b>6,388,000</b>	<b>173</b>	<b>5,456,136</b>	<b>91</b>	<b>4,020,401</b>	<b>63%</b>	<b>74%</b>

The table shows that, nationwide, 4,020,401 people residing in 91 (out of 1,042) localities are currently connected to wastewater collection and treatment systems; representing 63% of total current national population. On the other hand, these 91 localities are out of 173 localities that should be connected to wastewater collection and treatment systems based on the above criteria; in total these 173 localities currently represent 74% of the population. Nationwide, the 91 serviced localities are connected to 31 wastewater treatment plants (27 existing plus 4 under construction). In general, it can be said that all major localities which include metropolitan areas, cities, urban and suburban localities are served or slated to be served in the next few years. Another notable feature found in the table is that nearly 60% of the total national population (3,671,269 out of 6,388,000 people) is located within only 25 communities with a population greater than 50,000 people each.

For this study, a **planning horizon** from 2012 through 2035 is used. This planning horizon is divided into 3 periods (1) Immediate: now through 2015, (2) Short Term: 2016-2025, and (3) Long Term: 2026-2035. The criteria for determining which projects are assigned to which planning period are discussed below.

Several technical considerations and assumptions were used as the basis for this Strategic Wastewater Master Plan. In order to assess **wastewater generation** rates, the water allocation policy figures (Amman 120 l/cpd, other cities 100 l/cpd, suburbs and remote areas 80 l/cpd) were used. The wastewater generated was calculated assuming that 80% of the water supplied will become wastewater.

A further requirement of the Jordan Water Strategy is that the treated effluent from wastewater treatment plants complies with national standards (JS 893-2006). In order to evaluate the wastewater treatment needs and associated costs, the BOD loading contribution was selected as it provides a reliable means of estimating loadings from future population, and has a much larger impact on the treatment cost than the wastewater flow. The standard requires that wastewater treatment must produce effluent with BOD5 concentration of 60 mg/l or less, if the wastewater is discharged into wadis (in most instances this is the case). The BOD load contribution was, therefore, taken to be 65 grams per capita per day as it has already been accepted by WAJ for other studies. This then served to define the lower limit for the **level of treatment**, requiring at a minimum biological treatment such as activated sludge, trickling filters or their variations.

After defining the planning horizon, number of people to be served, the amount of wastewater to be treated and the level of treatment required, a needs assessment was then made in order to ascertain investment costs.

The two major **components which determine the costs** of wastewater systems are wastewater collection (sewers) and wastewater treatment (plants). Recent (2013) cost information available for collection sewers and house connections for various communities in Jordan were used for the estimates used in Strategic Wastewater Master Plan. The wastewater collection costs were calculated on the basis that collection sewers and house connections for areas within the existing wastewater collection service areas cost 303 JD/person, whereas the costs of collection sewers and house connections for areas where no wastewater collection system exists are 606 JD/person. As for treatment costs, since mechanical, biological treatment (e.g. activated sludge, trickling filters, and extended aeration) is considered as the anticipated treatment level, available cost information of similar wastewater treatment plants recently constructed or under construction as well as proposed for construction was reviewed, and presented in the table below. As the waste is domestic in

characteristics, the BOD concentration and per capita wastewater flows may change, but these will have minimal impact on the estimated cost of wastewater treatment.

#### **Wastewater Treatment Plant Unit Costs**

Capacity		Unit Cost (JD)	
m <sup>3</sup> /d	People	Per m <sup>3</sup> /d	Per Person
< 400	<5,000	2,100	170
400-600	5,000 – 7,500	1,800	150
600-800	7,500-10,000	1,600	130
800-1000	10,000-12,500	1,300	110
>1000	>12,500	1,100	90

The Master Plan determines the specific investments for wastewater collection and wastewater treatment projects on the basis of the following priority considerations:

Priority I (Immediate: 2013-2015) projects are proposed for immediate implementation. These are determined based on the following criteria:

Existing wastewater collection systems having sewer overflow problems, or the existing sewers are overloaded, or sewers lines are deteriorated, or there is an accessibility problem to maintain the sewer systems.

Expansion of an existing overloaded wastewater treatment plant or is currently operated very near its design capacity.

Priority II (Short-Term: 2016-2025) projects are proposed for near-term implementation as determined by the following criteria:

Localities within an existing sewer system still needing connection; expansion of wastewater treatment plants that will reach the maximum design capacity in the planning period of 2016-2025 or close to it; eligible localities currently relying on septic tanks but which have not created any overflow problems; and/or, localities exhibiting any other significant environmental or sanitation problems.

Localities that have the potential to contaminate groundwater or spring sources used for drinking water and do not have a wastewater collection and treatment system. In assessing the potential pollution of groundwater and spring water resources, the key risk factors considered were depth to the groundwater, geology and aquifer media, soil cover, proximity to wadis and high permeability wadi beds.

Priority III (Long-term: 2026 – 2035) projects are proposed for implementation from year 2026 or when excess funds are available after meeting the needs of Priority I and Priority II projects.

Localities (population centers) greater than 5,000 people in the planning period located in rural areas which do not have existing wastewater collection system and are not known to cause any environmental or groundwater contamination concerns.

Expansion of existing wastewater treatment plants needed to serve the future population growth expected to take place beyond year 2025.

As discussed above, rural localities with less than 5,000 population are not proposed for construction of wastewater collection systems. There may be some exceptions, however, based on sanitation and health considerations. In general, the septage, when collected, is proposed to be treated in nearby wastewater treatment plants or specially constructed septage treatment plants. Localities with a population of less than 5,000 are excluded from consideration to be provided with a wastewater collection system, unless they fall into Priority I or Priority II criteria projects based on their proximity to existing treatment and collection facilities or environmental risk. (less than 30 such localities are considered as these exceptions).

The following Table summarizes the current wastewater systems across the nation.

#### **Nationwide Wastewater System Overview (Current Situation)**

<b>Localities</b>	<b>Total No. of Localities</b>	<b>Total No. of People</b>
Localities Served by WW Systems (Collection & Treatment)	91 (totally and partly served) This No. includes 28 localities smaller than 5,000 people each	4,020,4013
Localities Larger than 5,000 people	173	5,461,037
No. of Localities (larger than 5,000 people) needing WW services	104	1,259,373

#### **Wastewater Treatment Plants**

<b>Total No. of Plants</b>	<b>31 (27 existing + 4 under construction)</b>
Total Capacity (Including plants under expansion or currently committed)	6,694,845 people
Calculated Total Population Currently Served	4,020,4013

As a result of the national Strategic Wastewater Master Plan, the following investment priorities and needs have been determined for each governorate within each Priority Period to meet the service criteria that has been developed and discussed above. The following table presents these findings and is the basis for the investment plan in wastewater in the country. All anticipated investment needs are presented in current JD costs, and are not adjusted for inflation.

**National Wastewater Collection & Treatment Systems Capital Investment Costs (Million JDs)**

Governorate	Priority I Immediate (now-2015)		Priority II 2016-2025		Priority III 2026-2035	
	Collection Cost	Treatment Cost	Collection Cost	Treatment Cost	Collection Cost	Treatment Cost
Amman	38.4	21.8	239.6	35.1	50.7	13.8
Balqa	9.3	9.2	6.5	26.1	46.5	15.5
Madaba	1.8	-	47.5	5.05	26.3	4.0
Zarqa	34.34	-	49.18	40.0	67.2	95.46
Irbid		29	86.25	23	262	51
Mafraq	4.67	-	44.4	-	36.8	8.1
Jerash		-	14	1	6	3.1
Ajloun		-	27	14	24	5
Karak	0.8	-	32.4		56.7	17.2
Tafilah	5.3	-	20.0	-	33.9	4.5
Ma'an	0.1	-	6	6	7.5	3
Aqaba		-	29	43	43	25
<b>Totals</b>	94.71	60	572.83	150.27	617.6	220.66

The Strategic Wastewater Master Plan lays the foundation for national planning to meet wastewater collection and service needs for the country. This plan now allows for the following immediate next steps:

- Develop detailed project descriptions for all Priority I activities;
- Develop detailed project design documents or move directly to Design-Build-Operate (DBO) tendering for the Priority I projects as soon as project descriptions are completed; and,
- Begin to organize Priority II projects for development of detailed project descriptions based on the time-sensitivity of each proposed project.

ISSP would like to thank the entire technical team responsible for the development of the national Strategic Wastewater Master Plan as well as all of the counterparts and colleagues in WAJ, MWI, the water utilities, USAID, the donor community and other donor projects who supported ISSP with critical information used for this report. The ISSP technical team members are: Dr. Ashok Lagvankar, Eng. Koussai Quteishat, Eng. Saddam Khleifat, Alan Brown, Eng. Radwan Akash, Eng. Mohammed Jalal, Dr. Marwan Raghad and Eng. Lana Zoubi.

# I INTRODUCTION

## I.1 BACKGROUND

The Wastewater Master plan was requested by the minister of MWI in the meeting with ISSP on June 30<sup>th</sup> 2013. H.E requested a simple strategic master plan that can help MWI in determining investment priorities in wastewater service in Jordan.

Although a tremendous number of studies have been done, on wastewater treatment and reuse for different cities and communities of all sizes in Jordan, and there are 27 operating wastewater facilities owned by Water Authority of Jordan (WAJ), in the various governorates across the Kingdom, no such strategic master plan has been prepared on the national level and priorities are, therefore, not identified.

Existing treatment plants are operated by WAJ, individual utilities, or by private sector. These plants are of different ages and levels of loading. Agglomerations are growing to form sizable communities which also require wastewater collection and treatment facilities. On the industrial front, significant efforts have been made, along with increased awareness, to encourage industry to invest in better water efficiency, treatment and recycling. Olive processes have been producing waste that causes significant environmental problems when discharged into wadis or operational problems when they reach wastewater treatment plants or questionable problems when stored in ponds awaiting solution. Sludge has been accumulating in some plants also awaiting solution, while in others needs further treatment to facilitate handling. Reuse of treated wastewater is very common in Jordan.

## I.2 OBJECTIVES

The primary objective of the strategic master planning exercise is to arrive at an investment plan for wastewater collection and treatment systems throughout the country that takes into consideration priorities for such investment through year 2035.

## I.3 SCOPE OF WORK

The scope of work for this study was developed to achieve the objectives of the strategic master plan. The major tasks include the following:

1. Review existing available information (reports, maps, etc.) relative to wastewater collection and treatment systems throughout the country.
2. Obtain population forecast data from the Department of Statistics (DOS) for all 12 governorates through year 2035 and make population projections on locality basis within each governorate.
3. Obtain and review all existing wastewater collection and treatments systems on governorate and locality basis and assess needs to serve future populations.
4. Estimate investment costs (immediate; short term – year 2015 through 2025; and long term 2025 through 2035) for wastewater collection and treatment for the governorates.
5. Develop priority criteria for investment.
6. Prepare strategic master plan report.

# 2 BASIS OF PLANNING AND STUDY APPROACH

## 2.1 INTRODUCTION

The following document provides main impetus for the preparation of the strategic master plan which delineates the needed improvements to wastewater collection and treatment systems throughout the country:

Water for Life: Jordan Water Strategy (2018-2022)

This document establishes the goals for wastewater to be achieved by 2022.

It states (Chapter 6):

“All major cities and small towns in Jordan are provided with adequate wastewater collection and treatment facilities”

The document also states:

“We will insure that the treated effluent complies with recently established national standards (JS 893-2006), and we will formulate Wastewater Master Plan, which will establish targets for providing wastewater collection systems and treatment facilities to un-served areas throughout the country”.

The document does not define the population of “small towns”. It is assumed that “Small Town” is the town that has current population that equals or exceeds 5,000 people.

Accordingly all large cities and towns larger than 5,000 people are considered for provision of wastewater collection system. Using this rationale to provide wastewater services, about 85% of the nation’s population will be served, and only about 15% of the population will be excluded from the wastewater collection systems.

It should be recognized that all wastewater discharges to wadis, streams etc., irrespective of the quantity of flow, must meet the effluent standards JS 893-2006. It is the law of the land. Based on the requirements, at a minimum, biological treatment of wastewater at all locations will be required.

Examples of biological treatment include aerated lagoons, extended aeration, activated sludge, trickling filters.

This chapter presents the study approach, basis of planning, population forecasting, cost estimation and rationale for other important elements necessary to develop a meaningful strategic master plan.

## **2.2 PLANNING HORIZON**

For this study a planning horizon from 2012 through 2035 is considered. This planning horizon is divided into 3 segments:

- Immediate: now through 2015
- Short Term: year 2016-2025
- Long Term: Year 2026-2035

## **2.3 POPULATION FORECAST**

The Department of Statistics (DOS) provided the population forecast data on governorate and National levels through year 2035.

Following observations were made:

- The population growth rate varies among governorates. For example Aqaba governorate is forecasted to grow by about 82% from 2012 to 2035 at an average annual growth rate of 2.7%; on the other hand Madaba governorate is forecasted to grow by about 52% from 2012 to 2035, at an average annual growth rate of 1.8%.
- Within the same governorate the growth rate is forecasted to decrease over time. For example for Madaba governorate the forecasted growth rate for the period 2015-2020 is 2.2% per year and for the period 2030-2035 it is about 1.4% per year.
- ISSP used this base population growth information provided by DOS and applied to all the localities within a governorate.

Annex 1 Tables present estimated population of each locality within a governorate through year 2035. This information was used to estimate wastewater flows, loads and to assess the service needs.

## 2.4 WASTEWATER GENERATION RATES

Wastewater generation rates depend on the water allocation rates. According to MWI policy allocation of per capita water supply is as follows:

- |                   |     |       |
|-------------------|-----|-------|
| - Amman           | 120 | 1 pcd |
| - Other Cities    | 100 | 1 pcd |
| - Suburbs         | 80  | 1 pcd |
| - Remote Villages | 80  | 1 pcd |

Wastewater generation rates were calculated assuming 80% of the water supplied will become wastewater.

For any given locality total wastewater flow is calculated by multiplying the number of people in that locality by appropriate wastewater generate rate. Primary impact of the wastewater flow will be on the size of the wastewater collection system.

## 2.5 WASTEWATER CHARACTERISTICS AND BOD CONTRIBUTION

Throughout the country, wastewater generated by all large and small localities (cities, suburbs, rural areas) is judged as municipal type, i.e. there is no significant impact of industrial wastewaters on the characteristics of resulting wastewater from all localities. This conclusion is valid because of the facts that the industries must meet pretreatment standards if they discharge into municipal wastewater systems and also because the amounts of wastewater generated by industries are rather very small (less than 10%) in comparison to the wastewater generated by population.

BOD load contribution is taken to be 65 grams per capita per day. The criterion was accepted by WAJ for studies done by other consultants. The BOD load is much more important (has much larger impact on the treatment cost than the wastewater flow) in order to evaluate the wastewater treatment needs and associated costs.

The approach of using BOD “load” contribution is critical, because it provides a reliable means of estimating future loadings from future population. It is possible that future water supply (consumption) rates may change considerably (upward or downward), thus changing the BOD concentration and per capita wastewater flows, but it will have minimal impact on the cost of wastewater treatment.

## 2.6 WASTEWATER EFFLUENT CRITERIA & TREATMENT LEVEL

Government of Jordan has established standards (JS 893-2006) for discharge of wastewaters into wadis, for irrigation and recharge. Following table presents summary of those requirements:

**Table 2-1: Summary of (JS 893-2006) Standards for Reclaimed Domestic Wastewater**

Parameter	Cooked vegetables A	Fruit & forestry trees, crops & industrial products B	Irrigation of fodder crops C	Irrigation of cut flower	Discharge to streams, wadis & reservoirs	Ground water recharge
BOD <sub>5</sub> (1)	30	200	300	15	60	15
COD	100	500	500	50	150	50
DO	>2	-	-	>2	>1	>2
TDS	1500	1500	1500	1500	1500	1500
TSS	50	200	300	15	60	50
PH	6.0-9.0	6.0-9.0	6.0-9.0	6.0-9.0	6.0-9.0	6.0-9.0
Turbidity	10	-	-	5	-	2
NO <sub>3</sub> <sup>-</sup> -N	30	45	70	45	-	30
Total-N	45	70	100	70	70	45
E.coli	100	1000	-	< 1.1	1000	< 2.2
Intestinal Helminthes eggs	≤ 1	≤ 1	≤ 1	≤ 1	≤ 0.1	≤ 1

Most important criterion to be considered for the wastewater master plan treatment is effluent BOD<sub>5</sub> concentration. The standard requires that wastewater treatment must produce effluent with BOD<sub>5</sub> concentration of 60 mg/l or less, if the wastewater is discharged into wadis (in most instances this is the case). In addition, the effluent nitrate and total nitrogen concentrations shall be equal to or less than 70 mg/l, if the effluent is used for irrigation.

These effluent requirements dictate that at a minimum biological treatment such as activated sludge, trickling filters or their variations, will be required to be provided.

In special cases, additional nitrification/de-nitrification treatment will be required. For this planning study, however, it is assumed that only biological treatment (activated sludge, trickling filter etc.) will be sufficient and treatment costs are developed on that basis.

## 2.7 COST ESTIMATION CRITERIA

The two major components which influence the costs of wastewater systems are: wastewater collection (sewers) and wastewater treatment plants.

For this planning study mechanical, biological treatment (e.g. activated sludge, trickling filters, and extended aeration) is considered as necessary treatment.

### 2.7.1 WASTEWATER COLLECTION SYSTEM

Very recently (February 2013) CDM-Smith reviewed cost information available for collection sewers and house connections (Ref. – Water/Wastewater Infrastructure Project/Tafleh Water/Wastewater Master Plan (Final) dated February 2013), for communities in the governorates of Amman, Jarash, Ma’an and Tafleh (about 25 communities). Based on that information ISSP has calculated the wastewater collection costs as follows:

- Cost of collection sewers and house connections for areas within the existing wastewater collection service areas – 303 JD/person
- Cost of collection sewers and house connection for areas where no wastewater collection system exists – 606 JD/person
- Cost of wastewater pipes with different known diameters were taken from 2012 CDM rates, and are shown in the table below:

**Table 2-2: Cost of Wastewater Pipes**

Pipe Diameter (mm)	CDM Rate (US\$/m)	CDM Rate (JD/m)
200	190	140
300	220	160
400	240	170
500	260	200
600	295	210
700	330	240
800	400	290
900	455	330
1000	525	380
1200	650	460
1500	890	640
1600	1,150	820
1800	1,275	910
2000	1,530	1100

## 2.7.2 WASTEWATER TREATMENT SYSTEM

Available cost information of wastewater treatment plants recently constructed or under construction as well as proposed for construction was reviewed. The list of constructed on under-construction plants include: South Amman, Ma'an, Shallaleh, Lajjoun.

The proposed treatment plant projects include: expansion of Wadi Musa WWTP; Jarash WWTP; Birein WWTP; Sarout WWTP.

Construction costs were estimated on per capita basis as follows:

**Table 2-3: Wastewater Treatment Plant Unit Costs**

Capacity		Unit Cost (JD)	
m <sup>3</sup> /d	People	Per m <sup>3</sup> /d	Per Person
< 400	<5,000	2,100	170
400-600	5,000 – 7,500	1,800	150
600-800	7,500-10,000	1,600	130
800-1000	10,000-12,500	1,300	110
>1000	>12,500	1,100	90

# 3 FACTORS INFLUENCING PROJECT PRIORITIES

ISSP proposes that investments for wastewater collection and wastewater treatment projects be made on the basis of following priority considerations:

- Priority I projects are proposed for implementation immediately (2013-2015).
- Priority II projects are proposed for implementation from year 2016-2025
- Priority III projects are proposed for implementation from year 2026-2035, or when excess funds are available after meeting the needs of priority I and priority II projects

## **Priority I Project Criteria:**

Examples of Priority I projects are:

- If the existing wastewater collection system has sewer overflow problems, or the existing sewers are overloaded, or sewers lines are deteriorated, or there is an accessibility problem to maintain the sewer systems, the construction projects to alleviate the problems will be assigned as priority I, immediate status.
- If an existing wastewater treatment plant is overloaded or is operated very near its design capacity, the expansion of the treatment plant will be assigned priority I.

## **Priority II Project Criteria:**

- For localities within an existing sewer system, expansion of wastewater treatment plants that reach the maximum design capacity in the period between 2016-2025 or close to it; are currently relying on septic tanks but have not created any overflow problems or any other environmental or sanitation problems; the construction project will be assigned priority II (proposed for construction, year 2016-2025).
- If a locality does not have a wastewater collection and treatment system; and poses a high potential to contaminate ground-water or spring sources used for drinking water, construction projects of wastewater collection and treatment system for the locality, irrespective of its size, will be assigned priority II.

In assessing the potential pollution of groundwater and spring water resources, the following key factors were considered:

- Depth to the groundwater.
- Geology and aquifer media.
- Soil cover.
- Wadis and high permeability wadi beds.

The complete study on identifying groundwater resources protection priority is included in Annex 4.

### **Priority III Project Criteria:**

Construction projects which do not meet priority I and II criteria will be assigned as priority III projects.

Examples of priority III projects:

- Localities (population centers) greater than 5,000 people located in rural areas which do not have existing wastewater collection system and are not known to cause any environmental or groundwater contamination concerns.
- Expansion of existing wastewater treatment plants needed to serve the future population growth likely to take place beyond year 2025.

### **Localities Excluded From Priorities:**

In general, rural localities with less than 5,000 population are not proposed for construction of wastewater collection systems. There may be some exceptions, however, based on sanitation and health considerations.

The septage, when collected, is proposed to be treated in nearby wastewater treatment plants or specially constructed septage treatment plants.

# 4 OVERVIEW OF NATIONAL WASTEWATER NEEDS ASSESSMENT

## 4.1 INTRODUCTION

This chapter presents national overview of:

- Existing and projected populations on governorate basis through year 2035.
- Nationwide existing wastewater systems overview.
- Nationwide, on governorate basis, wastewater collection and treatment needs for years 2013 through 2025; and 2026 through 2035.
- Nationwide planning level investment costs for years 2013 through 2025; and 2026 through 2035.
- Recommendation for further action.

## 4.2 POPULATION

Current (2012) nationwide total population is estimated (by DOS) to be 6,388,000. Amman, Irbid and Zarqa governorates are the three most populated, containing 4,562,300 people representing about 71% of total national population.

The total national population is forecasted (by DOS) to grow to 8,507,131 by year 2025, which represents a growth of about 33% over next 13 years. The population is further forecasted to grow to 9,902,325 by year 2035, representing a growth of about 55% over next 23 years.

Table 4-1 presents nationwide population projections on governorate basis.

**Table 4-1: Nationwide Population Projections on Governorate Basis**

Governorate	Population		
	2012	2025	2035
<b>Amman</b>	2,473,400	3,219,559	3,681,579
<b>Balqa</b>	428,000	573,720	671,101
<b>Madaba</b>	159,700	210,162	243,363
<b>Zarqa</b>	951,800	1,275,549	1,497,119
<b>Irbid</b>	1,137,100	1,519,625	1,764,207
<b>Mafrq</b>	300,300	408,825	485,343
<b>Jerash</b>	191,700	276,267	336,976
<b>Ajloun</b>	146,900	202,332	240,403
<b>Karak</b>	249,100	327,924	376,250
<b>Tafilah</b>	89,400	125,569	150,708
<b>Ma'an</b>	121,400	168,984	201,531
<b>Aqaba</b>	139,200	198,615	253,745
<b>Totals</b>	<b>6,388,000</b>	<b>8,507,131</b>	<b>9,902,325</b>

There are a total of 1,042 localities within all 12 governorates; these localities are as per information shown on DOS population tables. The nationwide distribution of population on locality size (population range) basis is presented in Table 4-2.

**Table 4-2: Nationwide Population Distribution by Size of Locality**

Population Range	No. of Localities	2012 Population	% of Total Population	Projected Population	
				2025	2035
<b>0-5,000</b>	869	931,865	14.6%	1,240,998	1,444,526
<b>5,001-10,000</b>	92	639,792	10.0%	852,034	991,770
<b>10,001-20,000</b>	35	498,799	7.8%	664,269	773,211
<b>20,001-50,000</b>	21	646,275	10.1%	860,668	1,001,820
<b>&gt; 50,000</b>	25	3,671,269	57.5%	4,889,162	5,690,999
<b>Total</b>	<b>1042</b>	<b>6,388,000</b>	<b>100%</b>	<b>8,507,131</b>	<b>9,902,325</b>

It should be noted that most localities (869 out of 1042) in the entire nation are very small, containing less than 5,000 people each. Nationwide, the total population currently residing in those localities is 931,865 representing about 14% of total national population.

Significance of this information is that these localities are excluded from consideration to be provided with a wastewater collection system, unless they fall into priority I or priority II criteria projects. (It has been noted a very small number, less than 30 are exceptions). In general, these localities are considered as rural communities and are generally on septic tank systems.

On the other side of the spectrum, close to 60% of the total national population (3,671,269 out of 6,388,000 people) are located within only 25 communities with a population greater than 50,000 people each.

A summary of nationwide population overview and locality wide population distribution is presented in Table 4-3.

**Table 4-3: Nationwide Population Overview**

<b>Population</b>	<b>All 12 Governorates</b>	<b>%Increase</b>
Year 2012	6,338,000 people	Base Year
Year 2025	8,507,131 people	33% (2,16913 people)
Year 2035	9,902,325 people	55% (1,395,194 people)
<b>Localities</b>	<b>All 12 Governorates</b>	<b>No. of People</b>
Total No. of Localities	1042	6,338,000
No. of Localities Larger than 5,000 People	173	5,461,037 (86%)
No. of Localities Smaller than 5,000 People	869	908,597 (14%)

## 4.3 EXISTING NATIONWIDE WASTEWATER COLLECTION AND TREATMENT

Summary of nationwide existing wastewater collection and treatment status on governorate basis is presented in Table 4-4.

**Table 4-4: Nationwide Existing Wastewater Collection & Treatment Status on Governorate Basis**

Governorate	Total Governorate		Localities larger than 5,000 people		Population Served with Wastewater Collection and Treatment Systems			
	No. of Localities	Population (2012)	No. of Localities	Number of Population	No. of Localities	Total Number	% of Total Governorate Population (2012)	% of Population Residing in Localities larger than 5,000 people
<b>Amman</b>	157	2,473,400	32	2,345,764	25	2,080,112	84%	89%
<b>Balqa</b>	80	428,000	17	328,784	11	184,000	43%	56%
<b>Madaba</b>	73	159,700	6	119,780	1	51,900	32%	43%
<b>Zarqa</b>	57	951,800	7	911,158	4	685,296	72%	75%
<b>Irbid</b>	137	1,137,100	54	981,378	12	594,404	52%	61%
<b>Mafraq</b>	172	300,300	12	139,102	1	24,000	8%	17%
<b>Jerash</b>	55	191,700	10	131,808	16	113,031	69%	86%
<b>Ajloun</b>	55	146,900	10	117,172	4	61,700	42%	53%
<b>Karak</b>	115	249,100	12	120,825	7	51,000	20%	42%
<b>Tafilah</b>	41	89,400	6	68,452	3	27,720	31%	40%
<b>Ma'an</b>	71	121,400	5	72,703	6	46,820	39%	64%
<b>Aqaba</b>	29	139,200	2	119,210	1	100,418	72%	84%
<b>Totals</b>	<b>1042</b>	<b>6,388,000</b>	<b>173</b>	<b>5,456,136</b>	<b>91</b>	<b>4,020,401</b>	<b>63%</b>	<b>74%</b>

### Notes:

1. Number of people served in most cases is less than the number of people residing in the locality where wastewater collection and treatment system exists.
2. The total number of served localities includes 28 localities with population of less than 5,000.
3. The served population in the above table includes the number of people who will be served by the WWTP currently under construction.

Nationwide, 3,951,465 people residing in 91 (out of 1042) localities are connected to wastewater collection and treatment systems; this represents 62% of total current national population.

As previously stated, nationwide, 869 localities which contain less than 5,000 people each representing 908,597 people in total are not recommended for construction of wastewater collection systems. So the clearer status is as follows:

- 91 localities out of 173 potential localities are currently served with wastewater collection and treatment systems; thus currently 3,951,465 people out of 5,479,403 people residing in localities larger than 5,000 people, are connected to wastewater collection and treatment systems, representing 72% of the served population.
- In general, it can be said that all major localities which include metropolitan areas, cities, urban and suburban localities, are served or slated to be served in the next few years.
- No untreated (raw) wastewaters are intentionally discharged to the wadis (except under emergency conditions).

Nationwide, the 91 localities are connected to 31 wastewater treatment plants (27 existing plus 4 under construction). Information on the treatment plants is presented in a table in Annex 2. The Annex also presents nationwide locations of these plants and contains a schematic of the treatment systems and their annual effluent discharge quantities which are generally reused for irrigation.

Summary of nationwide wastewater collection and treatment systems is presented in Table 4-5.

**Table 4-5: Nationwide Wastewater System Overview (Current Situation)**

Localities	Total No. of Localities	Total No. of People
Localities Served by WW Systems (Collection & Treatment)	91 (totally and partly served) This No. includes 28 localities smaller than 5,000 people each	4,020,4013
Localities Larger than 5,000 people	173	5,461,037
No. of Localities (larger than 5,000 people) needing WW services	104	1,259,373

**Wastewater Treatment Plants**

Total No. of Plants	31 (27 existing + 4 under construction)
Total Capacity (Including plants under expansion or currently committed)	6,694,845 People
Calculated Total Population Currently Served	4,020,4013

## **4.4 FUTURE WASTEWATER SYSTEMS NEEDS AND PROPOSED PRIORITIES**

It should be noted that nationwide there are 104 localities, larger than 5,000 people each, currently not served by wastewater collection and treatment systems. Total current population residing in these localities amounts to 1,259,373 people. These localities are identified on governorate basis in Table 4-6. The Table also presents proposed priorities (based on priority consideration factors presented in Section 3) for construction of wastewater collection and treatment facilities. It should be noted that the table also includes localities that have population less than 5,000 but are part of a proposed system to serve larger localities.

Table 4-6: Localities Identified for wastewater project implementation on priority basis

Governorate	District	Locality	Year 2012 Population	Priority II (2016-2025)		Priority III (2026-2035)		Priority Considerations
				Collection	Treatment	Collection	Treatment	
Ajloun	Qasabet Ajloun	Ebbien	8,686	X				To be served through existing Wadi Hassan WWTP (Jnaid Project)
		Halawah	7,042			X	X	-Far from existing system -No reported environmental and/or health issues
		Hashemiyyeh	8,056			X	X	
		Orjan	6,266			X	X	
		Sakhras	12,736	X				To be served through existing Wadi Hassan WWTP (Jnaid Project)
		Wahadneh	5,842			X	X	-Far from existing system -No reported environmental and/or health issues
Amman	Al-Jami'ah	Shafa Badran	19,528	X				To be served through existing system
	Na'oor	Binayat	7,936	X				-Part of South Amman wastewater networks networks Contract
		Na'oor	19,666	X	X			WWTP Construction is Priority 1

Governorate	District	Locality	Year 2012 Population	Priority II (2016-2025)		Priority III (2026-2035)		Priority Considerations
				Collection	Treatment	Collection	Treatment	
		Rawdhah	6,493			X		-Far from existing system -No reported environmental and/or health issues
		Um El-Basatien	5,902	X				-Part of South Amman wastewater networks Contract
		Um El-Sumaq	6,890	X				To be served through existing system
	Quaismeh	Khraibet Essooq, Jawa, Yadoodeh	108,222	X				-Part of South Amman wastewater networks Contract
		Um Qsair, Moqabaleen	46,848	X				
	Sahab	Abdaliyyeh	8,324			X		-Far from existing system -No reported environmental and/or health issues
		Khashafiyet Shamalyeh	5,415			X		
	Wadi Essier	Badr Jadedda	12,798	X				To be served through existing system
		Marj Elhamam	38,428	X				To be served through existing system
		Wadi Essier	155,421	X	X			To be served through existing

Governorate	District	Locality	Year 2012 Population	Priority II (2016-2025)		Priority III (2026-2035)		Priority Considerations
				Collection	Treatment	Collection	Treatment	
								system
<b>Aqaba</b>	Quaira	Quairah	10,060			X	X	-Far from existing system -No reported environmental and/or health issues
<b>Balqa</b>	Dair Alla	Balaooneh	6,409			X	X	-Far from existing system -No reported environmental and/or health issues
		Dair Alla	5,602			X	X	
		Dherar	7,567			X	X	
		Twal Janoobi	8,525			X	X	
	Qasabet Essalt	Sbaihi	5,137			X	X	To be served through existing system
		Yarqha	5,788	X				
	Shooneh Janoobiyyeh	Joafet El-Kafrain	6,951			X	X	-Far from existing system -No reported environmental and/or health issues
		Karamah	10,024			X	X	
		Ramah	5,213			X	X	
		Roudhah	9,821			X	X	

Governorate	District	Locality	Year 2012 Population	Priority II (2016-2025)		Priority III (2026-2035)		Priority Considerations
				Collection	Treatment	Collection	Treatment	
Irbid	Aghwar Shamaliyyeh	Kraymeh	19,272			X	X	-Far from existing system -No reported environmental and/or health issues
		Manshiyyeh	7,786			X	X	
		Mashari'e	22,394			X	X	
		Shaikh Hussein	8,682			X	X	
		Shoonch Shamaliyah	17,597			X	X	
		Wadi El-Raian	6,616			X	X	
	Bani Kenanah	Waqqas	6,387			X	X	
		Hatem	6,629			X	X	
		Kharja	5,283			X	X	
		Kofor Soom	8,377			X	X	
		Malka	7,784			X	X	
	Kora	Saham	7,226			X	X	
		Ashrafiyyeh	10,474			X	X	

Governorate	District	Locality	Year 2012 Population	Priority II (2016-2025)		Priority III (2026-2035)		Priority Considerations
				Collection	Treatment	Collection	Treatment	
		Bait Iedes	5,875	X	X			-To be served through existing system (Birqish Project) -Hot Spot
		Dair Abi Sa'id	16,896			X	X	-Far from existing system -No reported environmental and/or health issues
		Jdaitta	13,975	X	X			-To be served through existing system (Birqish Project) -Hot Spot
		Kofor Abil	8,093	X	X			
		Kofor Awan	9,853	X	X			
		Kofor El-Ma'	12,052			X	X	-Far from existing system -No reported environmental and/or health issues
		Kofor Rakeb	5,147	X	X			-To be served through existing system (Birqish Project) -Hot Spot
		Rahwah	223	X	X			
		Sammo'	7,610			X	X	-Far from existing system -No reported environmental and/or health
		Tebneh	6,934			X	X	

Governorate	District	Locality	Year 2012 Population	Priority II (2016-2025)		Priority III (2026-2035)		Priority Considerations
				Collection	Treatment	Collection	Treatment	
	Mazar Shamali	Dair Yoosef	7,016			X	X	issues
		Enbeh	7,958			X	X	
		Mazar Shamali	14,839			X	X	
		Rhaba	9,144			X	X	
	Qasabet Irbid	Al'al	5,343			X	X	
		Bait Ras	22,078	X				To be served through existing system in Irbid
		Bait Yafa	9,280			X	X	-Far from existing system -No reported environmental and/or health issues
		Hakama	9,093	X				To be served through existing system in Irbid
		Kofor Yooba	13,780			X	X	-Far from existing system -No reported environmental and/or health issues
		Mghayyer	10,625	X				To be served through existing system in Irbid

Governorate	District	Locality	Year 2012 Population	Priority II (2016-2025)		Priority III (2026-2035)		Priority Considerations
				Collection	Treatment	Collection	Treatment	
		Zahar	5,701			X	X	-Far from existing system -No reported environmental and/or health issues
	Ramtha	Bwaidhah	6,677			X	X	To be served through existing Ramtha WWTP (Sahl Horan Project)
		Dnaibeh (1)	2,594	X				
		Emrawah (1)	4,622	X				
		Shajarah	14,115	X				
		Torrah	18,183	X				
	Tayybeh	Dair Ess'eneh	5,941			X	X	-Far from existing system -No reported environmental and/or health issues
		Samma	10,540			X	X	
		Taybeh	15,570			X	X	
	Wastiyyah	Kofor Asad	9,875			X	X	
		Qmaim	6,256			X	X	
	Jarash	Qasabet Jarash	Baliela	6,195	X			
Borma			5,575			X	X	-Far from existing system -No reported environmental and/or health issues

Governorate	District	Locality	Year 2012 Population	Priority II (2016-2025)		Priority III (2026-2035)		Priority Considerations
				Collection	Treatment	Collection	Treatment	
		Kofor Khall	7,007	X				To be served through existing Wadi Hassan WWTP (Inaid Project)
Karak	Aghwar Janoobiyyeh	Ghawr Almazra'a	8,423			X	X	-Far from existing system -No reported environmental and/or health issues
		Ghawr Safi	20,435			X	X	
	Ayy	Ayy	5,837	X	X			Hot Spot
	Faqqoo'	Faqo'e	5,984			X	X	-Far from existing system -No reported environmental and/or health issues
		Serfa (1)	4,902			X	X	
	Mazar Janoobi	Tayybeh	6,114	X	X			Hot Spot
	Qasr	Qasr	5,424			X	X	-Far from existing system -No reported environmental and/or health issues
		Rabbah	5,582			X	X	
Qetraneh	Qatraneh	5,667			X	X		
Ma'an	Husseiniyyeh	Huseiniya	7,536			X	X	-Far from existing system -No reported environmental and/or health issues
	Qasabet Ma'an	Jafr	6,743	X	X			Hot Spot

Governorate	District	Locality	Year 2012 Population	Priority II (2016-2025)		Priority III (2026-2035)		Priority Considerations
				Collection	Treatment	Collection	Treatment	
Madaba	Dieban	Dieban	7,131			X	X	-Far from existing system -No reported environmental and/or health issues
		Mlaih	7,182			X	X	
	Qasabet Madaba	Faisaliah	6,101	X				To be served through existing Madaba WWTP
		Maeen	6,550	X	X			Hot Spot
		Ma'moneia	6,380	X				To be served through existing Madaba WWTP
Mafraq	AlRuwaished	Rwaished	5,179			X	X	-Far from existing system -No reported environmental and/or health issues
	Badiyah Shamaliyyeh	Roadhet Basmah	5,579			X	X	
		Sabha	6,283			X	X	
		Um-Elqotain	5,349			X	X	
	Badiyah Shamaliyyeh	Khaldiyah	12,710	X				To be served through existing As Samra WWTP
		Mabrukah	5,246	X				
		Mghayyer Serhan	7,385	X				
	Gharbiyyeh	Za'tary	6,218			X	X	-Far from existing system -No reported environmental and/or health issues
Qasabet	Bal'ama	10,551	X				To be served	

Governorate	District	Locality	Year 2012 Population	Priority II (2016-2025)		Priority III (2026-2035)		Priority Considerations
				Collection	Treatment	Collection	Treatment	
	El- Mafraq	Manshiyyet Bani Hasan	8,354	X				through existing Mafraq WWTP
Tafleeh	Bsaira	Bsaira	8,170			X	X	-Far from existing system -No reported environmental and/or health issues
		Gharandal (1)	4,743			X	X	
		Qhadesiyeh	8,237			X	X	
	Hesa	Hasa	9,264			X	X	
Zarqa	Hashemiyyeh	Sokhneh	15,793	X				To be served through existing As Samra WWTP
	Qasabet Ezzarqa	Azraq Janoobi <sup>(1)</sup>	2,188	X	X			Hot Spot
		Azraq Shamali	5,891	X	X			
		Dhlail	34,412	X				To be served through existing As Samra WWTP
		<sup>(1)</sup> Locality has population less than 5,000 people						

## 4.5 NATIONWIDE WASTEWATER COLLECTION & TREATMENT SYSTEMS CAPITAL INVESTMENT COSTS

ISSP reviewed population projects, existing system capacities and estimated future wastewater system needs on locality basis; proposed priorities for projects and estimated capital investment costs.

Summary of capital investment costs on governorate basis, for wastewater collection and treatment systems is presented in table 4-7. Details of improvements needs on locality basis and on priority basis are presented in governorates wastewaters need assessment (chapter 5-16). The wastewater projects are estimated to costs 1,715.84 million JDs through year 2035 over and above the costs for already committed projects.

**Table 4-7: National Wastewater Collection & Treatment Systems Capital Investment Costs (Million JDs)**

Governorate	Immediate		2016-2025		2026-2035	
	Collection Cost	Treatment Cost	Collection Cost	Treatment Cost	Collection Cost	Treatment Cost
Amman	38.4	21.8	239.6	35.1	50.7	13.8
Balqa	9.3	9.2	6.5	26.1	46.5	15.5
Madaba	1.8	-	47.5	5.05	26.3	4.0
Zarqa	34.34	-	49.18	40.0	67.2	95.46
Irbid		29	86.25	23	262	51
Mafraq	4.67	-	44.4	-	36.8	8.1
Jerash		-	14	1	6	3.1
Ajloun		-	27	14	24	5
Karak	0.8	-	32.4		56.7	17.2
Tafilah	5.3	-	20.0	-	33.9	4.5
Ma'an	0.1	-	6	6	7.5	3
Aqaba		-	29	43	43	25
<b>Totals</b>	94.71	60	572.83	150.27	617.6	220.66

**Notes:**

1. Costs are in 2013 JDs
2. Costs shown do not include contingencies

## **4.6 ISSUES RELATED TO CENTRALIZED VS DECENTRALIZED WASTEWATER TREATMENT PLANTS**

As a result of this planning study ISSP has identified about 104 localities throughout the country which will need wastewater systems over the next 10 to 20 years (through year 2035). Collectively the wastewater projects are estimated to cost 1,715.84 million JDs through year 2035 (this amount is over and above the amount already committed). At this level of study ISSP cannot identify which localities could join together for wastewater treatment for better efficiency and increased cost effectiveness. For the sake of this study, average treatment and network connections are considered. Specific site conditions invariably affect these costs and are usually decided on the basis of detailed feasibility and design studies.

# 5 AMMAN

## Summary of Wastewater Assessment

Amman Governorate has a current population of 2,473,400 (2012) which is projected to grow to 4,102,847 in 2035, an increase of 66% over the next 23 years. The population is distributed over 157 localities of which 32 have a population greater than 5,000. The remaining 125 localities have populations less than 5,000.

Within the sewerred localities collectively 2,080,112 people are connected to the sewer system representing 84% of the total governorate population. There are 6 existing wastewater treatment plants and 1 pump station to As Samra TP (West Zarqa Pumping Station (WZPS)). The plants have a combined total design capacity capable of serving 3,687,500 people. This implies that the existing treatment plants collectively have available treatment capacity for an additional 1,607,388 people.

Based on the projected population of 3,292,487 by year 2025 and 4,102,847 by year 2035, the following wastewater systems and treatment needs are estimated:

	Immediate (to 2015)	Year 2025	Year 2035
<b>Needs</b>	<ol style="list-style-type: none"> <li>1. Additional wastewater collection and treatment systems</li> <li>2. Wadisseeer WWTP Expansion</li> </ol>	<ol style="list-style-type: none"> <li>1. Additional wastewater collection and treatment systems</li> <li>2. Septage wastewater treatment for 102,826people</li> </ol>	<ol style="list-style-type: none"> <li>1. Additional wastewater collection and treatment systems</li> <li>2. Septage wastewater treatment for 101,731 people</li> <li>3. New WWTP</li> </ol>
<b>Estimated Costs</b>	<ol style="list-style-type: none"> <li>1. 48.4 million JD</li> <li>2. 11.8 million JD</li> </ol>	<ol style="list-style-type: none"> <li>1. 265.7 million JD</li> <li>2. 9 million JD</li> </ol>	<ol style="list-style-type: none"> <li>1. 50.7 million JD</li> <li>2. 8.9 million JD</li> <li>3. 4.9 million JD</li> </ol>

Details of the analysis of the existing situation with respect to wastewater collection and treatment and needed improvements for the future (up to 2035) with associated investment costs are presented in the following sections.

Costs of expansion of the WWTP and network expansion for year 2015, and 2025, and 2035 are estimated as shown in the following summary Table.

Governorate Total (MJOD)			
Priority	2012-2015	2016-2025	2026-2035
Capital Costs	60.2	274.7	64.5
Yearly Expansion programs	5.96 yearly		

Other small localities will need to continue the current practice of discharging domestic wastewater flows to the septic pits if there were no records for health or water pollution problems.

## Introduction

Amman is the capital and largest city of Jordan. It is the country's political, cultural and commercial center and one of the oldest continuously inhabited cities in the world. Amman 2012 population is 2,473,400 in 2012, projected to be 4,102,847 in 2035. Amman accounts for 39% of the Kingdom population.

Amman is situated in a hilly area of north-western Jordan. The city was originally built on seven hills, but now spans over an area of nineteen hills (each known as a Jabal, Tál, Mount or Mountain). The main areas of Amman are named after the hills and mountains on which slopes they lie. The city's elevation changes from mountain to mountain and ranges between 700 to 1100 m.

The governorate has 157 localities distributed over 9 districts:

- Amman Qasabah district
- Marka district
- Alquaismeh district
- Al-Jami'ah district
- Wadisseer district
- Sahab district
- Jizeh District
- Mowaqqar district
- Na'oor district

Figure 5-1 shows the districts and localities in the Amman governorate.

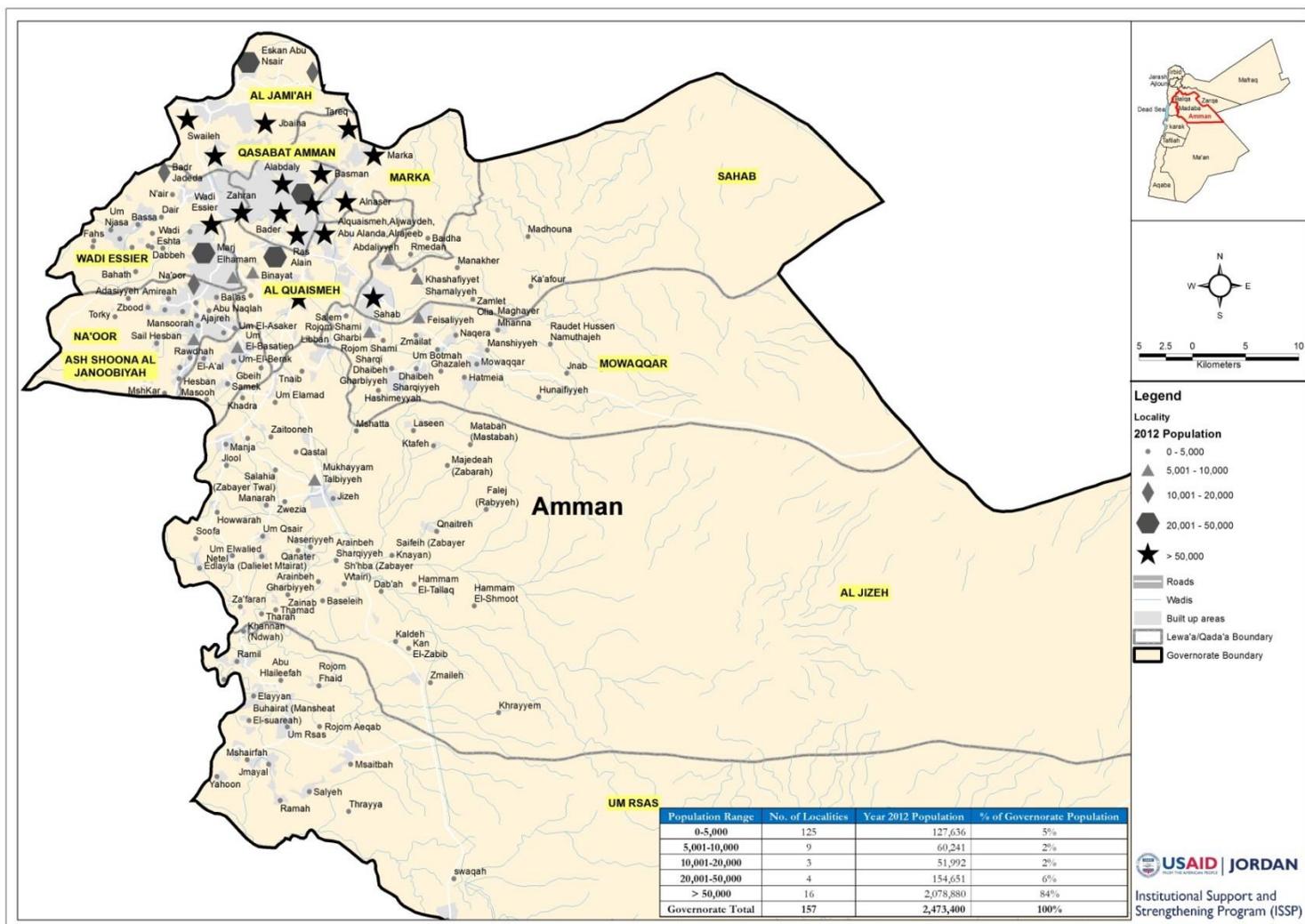


Figure 5-1: Amman governorate districts and localities

## Wastewater Service Areas

The existing sewer service areas in Amman governorate cover most of the central, western, and eastern parts of the city of Amman which are served through Ain Ghazal pre-treatment plant (AGTP). The northeastern part of the City is served through West Zarqa PS. Both Ain Ghazal and West Zarqa systems flow to As Samra WWTP. Stand alone sewer systems in Abu Nseir area in northern Amman, Wadi Es-Seer in western Amman and Al-Jeeza in southern Amman are in operation, whereas a WWTP is currently under construction in South Amman, and a WWTP and collection system have yet to be constructed in Naour, Southeast Amman.

Existing sewer systems service about 84% of the total governorate population. Figure 5-2 shows the locations of the above seven wastewater systems in the Amman governorate.

**Ain Ghazal Service Area:** Of the total area served at present, 65 percent (central and western Amman) are served by the AGTP. The areas served include the Districts of Basman, part of An-Nasir, Al-Madeena, Al-Yarmouk, parts of Al-Qweismah, Abu Alanda, and Al-Jwaydah, Al-Abdali, part of Al-Jubeihah, Ras al-Ein, Badir, Zahran, part of Marj Al Hamam, part of Wadi Es-Seer, 'Tlaa' Al-Ali, Um As-Summaq, Khalda, and part of Sweileh. Trunk mains in the service area are 300mm to 1500mm diameter pipes, and collector sewers are generally 200mm in diameter but may be larger at certain locations. The total length of trunk mains in the AGTP system is approximately 270 km. The existing collection system covers most of the areas that naturally drain to AGTP. The only currently unserved areas that could be served by the system are small areas east of the existing system and a small area in the south surrounding Marj al-Hamam.

**West Zarqa Pump Station Service Area:** The WZPS serves north Amman as well as Russeifa and west Zarqa in the Zarqa governorate. The north Amman areas include the Districts of Tariq and parts of Shafa Badran, Marka, Al-Jubeiha, and Basman. Trunk sewers in the WZPS system are 300mm to 800mm in diameter. The total length of trunk sewers in the WZPS network within Amman is approximately 76 kilometers. At the WZPS, wastewater flows are pumped into the 1,200 mm siphon to the As Samra WWTP.

The existing collection system covers most of the areas that naturally drain to WZPS. Future expansion areas that could be served by the existing system include areas east of Marka and small areas north of the existing service area.

**Abu Nseir Service Area:** The system serves the Abu Nseir housing complex and the surrounding areas including Hay As-Sa'ada, Hay Al-Basala, parts of Hay Al-Farouq, Hay Al-Amana and Hay Ad-Diaa. It receives domestic sewage mainly from residential areas. The system serves a population of 25,800 via 5 km of trunk sewers serving an area of 2.5km<sup>2</sup>.

The Abu Nsair catchment area is served by a 4,000 m<sup>3</sup>/d capacity WWTP that was commissioned in 1986. Diversion of the flows of this WWTP to WZPS catchment area will increase the flow to As Samra WWTP by 4,557 m<sup>3</sup>/d in year 2035.

**Wadisseeer Service Area:** This system serves the following areas: Dabouq in Suwieleh District in the north; the northeastern parts of Badr al-Jadeeda District including the Hussein Medical City; the western parts of Hay Al-Jandaweel and Hay Al-Rawnaq; Hay Al-Koursi and Hay Wadisseeer; as well as the villages of Iraq al-Ameer, Bassa and Al-Hamediya in Wadisseeer District. The sewerage system serves an area of 12 km<sup>2</sup> having a population of 42,800.

The collection network system consists of 26 km of sewers ranging in diameter from 200 mm to 500 mm. The Wadisseeer Interceptor is a 12.4 km, 500 mm diameter sewer that conveys the wastewater flow to the treatment plant. It also serves the villages of Iraq al-Ameer, Bassa and Al-Hamediya.

The collection system could be expanded to serve the areas and villages of Badr al-Jadeedah, west of the existing collection system and also areas south of Wadisseeer.

**Al-Jeeza Service Area:** This system serves the town of Al-Jeeza, located 32 km south of the City of Amman on the Desert Highway, and the Al-Talbiah refugee camp. Construction of both the sewer network and the WWTP was completed in 2009. The wastewater system serves a population of about 12,000. The total sewer length is 33 km serving an area of 1.8 km<sup>2</sup>. Based on the 2004 census survey, the 2010 populations of the town of Al-Jeeza and Al-Talbiah camp were estimated to be 4,551 and 7,787, respectively. The Al-Jeeza sewer system comprises two networks: the Al-Jeeza town sewer network and the Al-Talbiah camp sewer network. These two networks discharge to the Al-Jeeza WWTP through three trunk sewers.

**South Amman Service Area:** The service area boundary generally follows the natural drainage boundaries of a series of undulating wadis that converge at Wadi al-Jeeza, a major tributary of Wadi Wala, near the town of Al-Jeeza. WAJ has designed sewer networks for eight localities: Sahab, Faisaleyeh, Rujum El-Shami, Khraibet Es-Souq, Nuzha, Jwaideh, Qweismeh, and Abu Alanda. These are located in the northern parts of the planned service area. The total designed service area in the eight localities is approximately 32 km<sup>2</sup>.

Construction of the South Amman wastewater system is being implemented through fourteen contract packages. Construction of the service networks, collectors CS and F, and Trunk Lines A and B commenced in 2009 and is still in progress. Construction of Trunk Line T and the WWTP started in 2010 and is in progress. The total sewer length is 425 km, ranging in diameter from 200 mm to 1,500 mm.

The system being installed under the current construction contract only serves the towns and villages in the north of the catchment area of the WWTP. Collection systems and trunk sewers to serve the areas and villages in the west of the catchment area are currently being designed.

**Naour Service Area:**The Naour District, consisting of 14 villages, is located to the west of Amman and is one of the 27 districts of Greater Amman Municipality. It is an agricultural district, known for its olive trees.

In January 2008, WAJ entered into a consultancy services contract with ISAN Corporation to provide final design and tender documents for the Naour wastewater system consisting of wastewater collection networks, main trunk lines, WWTP, and effluent lines. The final design and tender documents were submitted to WAJ in 2010. Tendering for construction of the project was on hold due to resistance from abutters. Final WAJ decision is to expand Wadisseer WWTP capacity and connect Naour sewer system to it.

The proposed Naour sewer system will serve the areas of Naour, Balas, Al-Aamreaih, Manshiyyeh and Um El-Qottain, Bassat Naour, parts of Marj Al-Hamam, and Zabood. Most of these future expansion areas lie west of the proposed system in addition to two small areas east of the system.

The proposed sewerage system includes one pump station to serve the Bal'as area. Flow from the Bal'as area will be pumped through a 250 mm diameter pipe to the Naour collection network. The capacity of the pump station is 145 m<sup>3</sup>/hr with a total dynamic head of 65 m. The total length of the sewer network system will be 191 km.

## Wastewater Treatment

**Ain Ghazal Pre-treatment Plant:**The AGTP has a capacity of 150,000 m<sup>3</sup>/d. The average 2010 flow was 156,000 m<sup>3</sup>/d with approximately 10,000 m<sup>3</sup>/d from septage. WAJ signed an agreement in 2008 with Engicon Consultants to prepare a detailed design and tender documents for a new septage wastewater treatment plant and effluent reuse, with a capacity of 10,000 m<sup>3</sup>/d.

**West Zarqa Pump Station:**The WZPS was commissioned in 1985 and was refurbished in 2009 by installing new pumps and electrical works. The capacity of the refurbished pump station is 72,000 m<sup>3</sup>/ d. At the WZPS, wastewater flows are pumped into the 1,200 mm siphon to the As-Samra WWTP.

**Abu Nseir WWTP:**The Abu Nseir WWTP was commissioned in 1986, the Abu Nseir WWTP was designed for a flow capacity of 4,000 m<sup>3</sup>/d and a loading capacity of 4,400 kg BOD/d to serve the Abu Nseir housing complex and the surrounding areas. The plant site is limited to 23 dunums with limited space available for expansion. Year-2010 average wastewater flow received at the plant was 2,449 m<sup>3</sup>/ d with an average BOD loading of 1,999 kg/d.

**Wadisseeer WWTP:**The Wadisseeer WWTP is located in a 300 dunum area south of Iraq al-Ameer village, 25 km west of Amman. The WWTP, commissioned in 1996, with a design capacity of 4000 m<sup>3</sup>/d was receiving, in 2010, an average flow of 3,552 m<sup>3</sup>/d. The biological treatment process in the treatment plant is waste stabilization ponds aided with mechanical aeration.

Recently, WAJ decided to expand the plant to accommodate loads from Naour Service Areas.

The treated effluent from Wadisseeer WWTP will be collected and conveyed to the location of the Baptism site and will be utilized there for irrigation.

**Al-Jeeza WWTP:**The Al-Jeeza WWTP treats wastewater from the town of Al-Jeeza and the Al-Talbiah refugee camp. Construction of both the sewer network and the WWTP was completed in 2009 with a design capacity of 4000 m<sup>3</sup>/d. Wastewater flow in 2010 was 704 m<sup>3</sup>/d.

**South Amman WWTP:**The South Amman WWTP, currently under construction, was originally intended to be located at Dhuhaibeh, north of Queen Alia International Airport, according to the detailed design prepared by MWH in 1999. However, the location of the plant was challenged by local residents and the decision was made to relocate the plant to a site near the present location.

The WWTP was designed with a capacity of 52,000 m<sup>3</sup>/d for year 2025 and 72,000 m<sup>3</sup>/d for year 2035 with a modified extended aeration process. The WWTP was designed to serve a population of 831,000 by 2035.

A Summary of existing Amman wastewater systems is given in Table 5-1

**Table 5-1: Summary of Existing Wastewater Systems in Amman**

System	Service Area (km <sup>2</sup> )	Capacity (m <sup>3</sup> /d)	Sewer Length (km)	Year 2010	
				Population	Flow (m <sup>3</sup> /d)
Ain Ghazal Pre-treatment Plant	160	150,000	1,767	1,519,200	156,045
West Zarqa Pump Station	88	72,000	383	206,200	17,852
Abu Nseir WWTP	3	4,000	48	25,800	2,449
Wadisseeer WWTP	12	4,000	89	42,800	3,552
Al-Jeeza WWTP	2	4,000	30	12,000	704
South Amman WWTP	30[2]	52,000	[1]	161,000	[1]
Totals	295	286,000	2,317	1,976,000	180,602

[1] The South Amman WWTP system is under construction.

[2] This number only includes the areas where sewer networks are being constructed. The potential service area of South Amman WWTP is much larger.

Figure 5-2 shows the locations of existing wastewater systems in the Amman governorate.

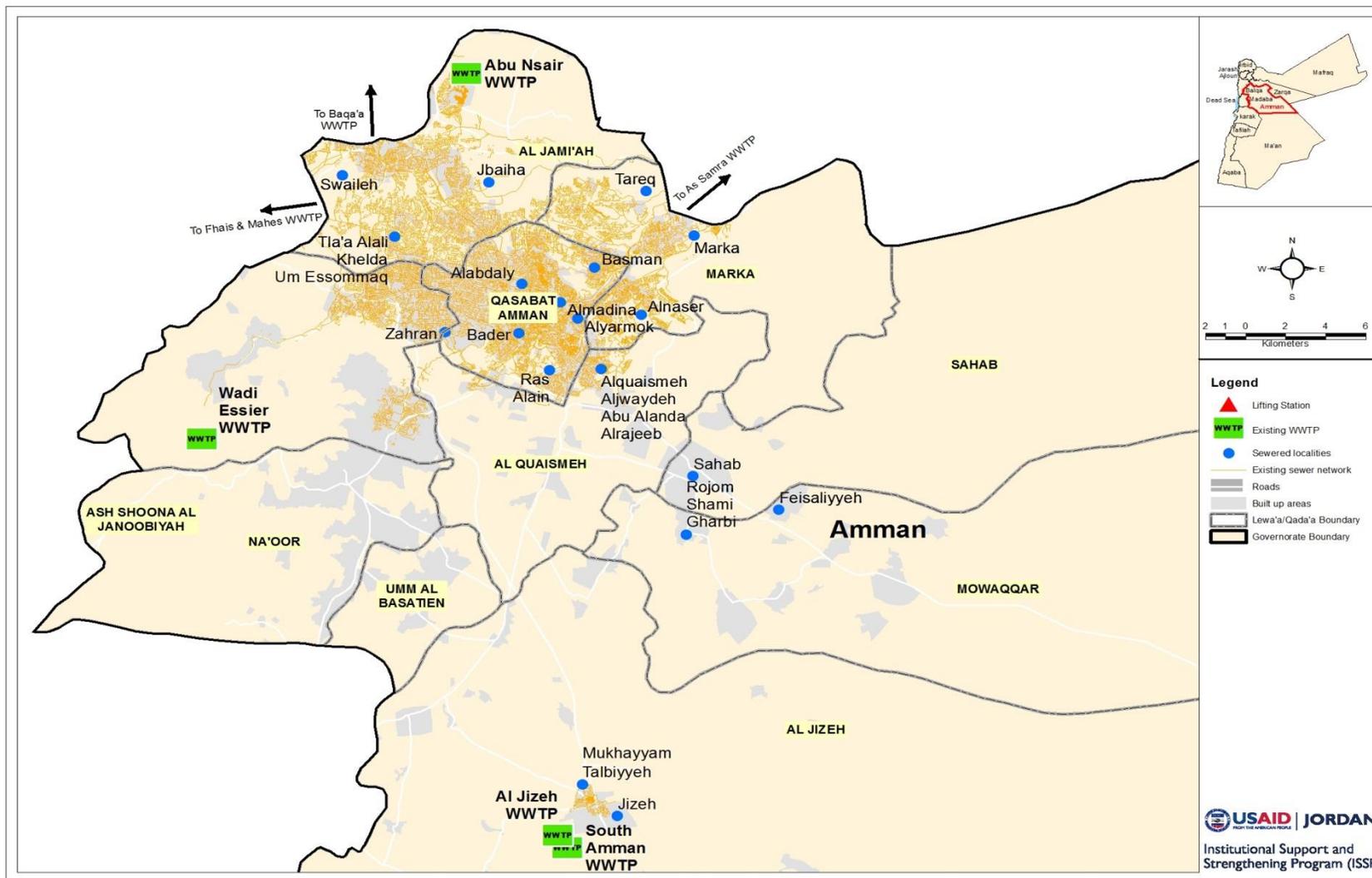


Figure 5-2: Existing wastewater systems in Amman governorate

## Unsewered Areas:

The two wastewater systems which flow to the As Samra WWTP are the Ain Ghazal Treatment Plant (AGTP) and the West Zarqa Pump Station (WZPS) wastewater catchment areas. These wastewater systems have areas which are unsewered (built up areas with no sewerage networks) and areas which are expanding and will continue to expand in the future. The unsewered areas and the future areas (vacant lands or sparsely populated areas) considered herein are within the natural drainage boundaries for the respective wastewater systems.

Table 5-2 and 5-3 show unsewered localities in served and unserved areas, respectively within Amman governorate.

**Table 5-2: Unsewered Localities with Population over 5,000 within Served Areas in Amman Governorate**

Areas	Current unsewered Population (2012)	% of Governorate Population
Shafa Badran	13,633	0.55%
Marka and Nasr	15,090	0.61%
Abu Nsair	30,052	1.22%
Abu Alanda and al-Queisma	15,905	0.64%
Hay al-Sahaba & Marj al-Hamam	8,103	0.33%

**Table 5-3: Unsewered Localities with Population over 5,000 within Unserved Districts in Amman Governorate**

District	Locality	Current unsewered Population (2012)	% of Governorate Population
Quaismeh	Um Qsair, Moqabaleen*	32,794	1.33
Quaismeh	Khraibet Essooq, Jawa, Yadoodeh*	75,755	3.06
Sahab	Khashafiyet Shamalyeh	5,415	0.22
Sahab	Abdaliyyeh	8,324	0.34
Na'oor	Um El-Basatien	5,902	0.24
Na'oor	Rawdhah	6,493	0.26
Na'oor	Binayat	7,936	0.32
Na'oor	Um El-Sumaq	6,890	0.28
Wadisseer	Badr Jadedda	12,798	0.52
Wadisseer	Marj Elhamam*	26,900	1.09
Wadisseer	Wadi Essier*	108,795	4.4

\*30% of the residents are assumed to be served

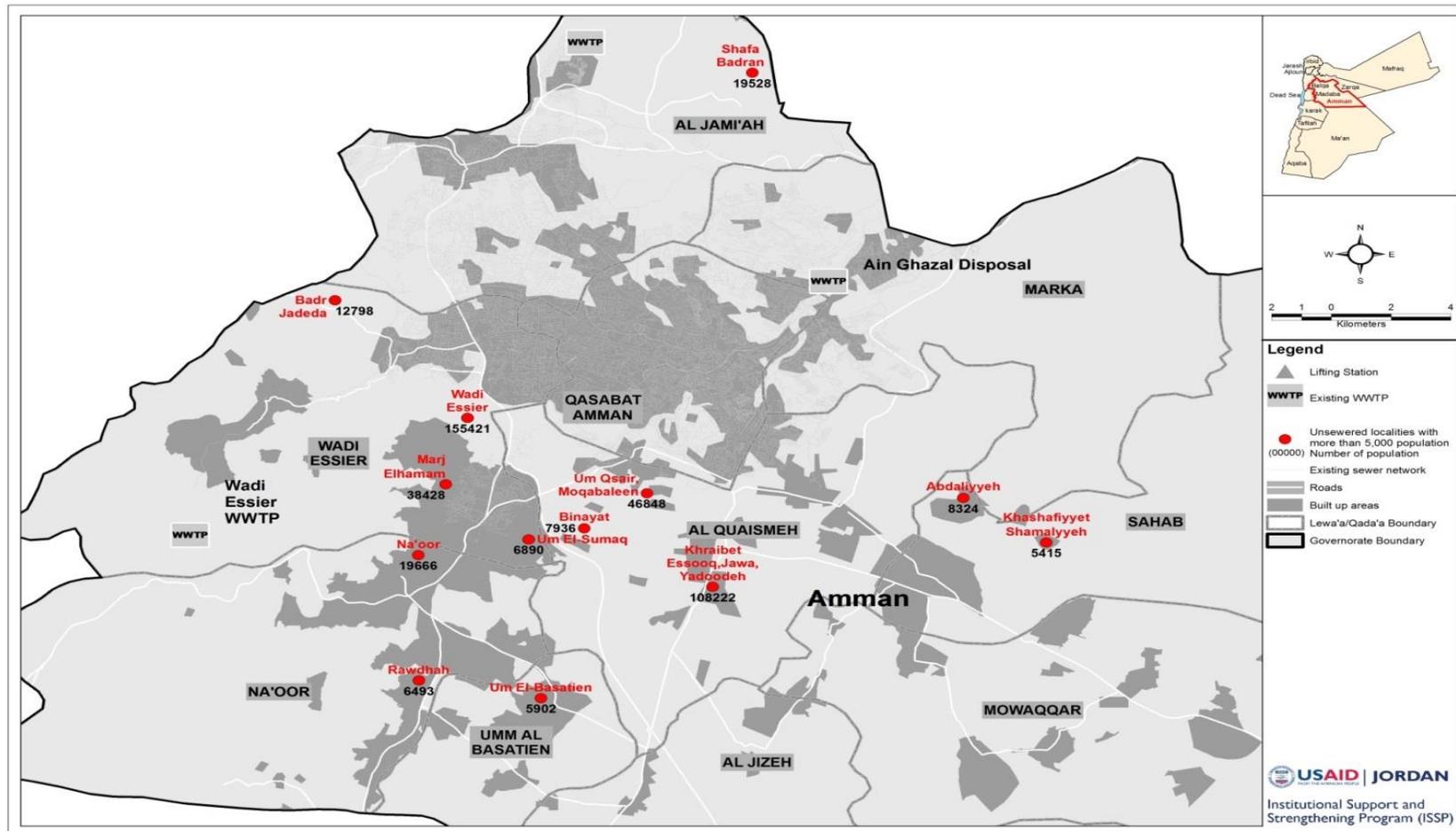


Figure 5-3: Unsewered localities in Amman Governorate

## Projected Wastewater Loads

Table 5-4 below shows WWTP status, and the population served by those plants projected through 2035. The table also shows the extent of the unserved localities with populations less and more than 5,000. Projection figures for flows and BOD loadings at Ain Ghazal, WZPS, Abu Nseir, Wadi Es-Seer, Al-Jeeza, South Amman, and Naour are shown in Table 5-5.

**Table 5-4: WWTP Status with Served and Unsewered Populations in Amman**

Service System	WWTP	Status	Estimated Served Population (2012)	% of total Gov. Population	Projected Population				
					2015	2020	2025	2030	2035
Ain Ghazal	Ain Ghazal Pre-treatment plant	Existing	1,588,312	64.2%	1,696,697	1,894,022	2,114,295	2,360,186	2,634,674
WZPS	West Zarqa Pump Station	Existing	215,581	8.7%	230,292	257,074	286,972	320,346	357,602
Abu Nseir	Abu Nseir WWTP	Existing	26,974	1.1%	28,814	32,165	35,906	40,082	44,744
Wadisseeer	Wadisseeer WWTP	Existing	44,747	1.8%	47,801	53,360	59,565	66,493	74,226
Al-Jeeza WWTP	Al-Jeeza WWTP	Existing	12,546	0.5%	13,402	14,961	16,701	18,643	20,811
South Amman	South Amman WWTP	Under construction	168,324	6.8%	179,811	200,722	224,066	250,125	279,214
Naour	Wadisseeer WWTP	Designed but not built yet	23,628	1.0%	25,240	28,176	31,453	35,111	39,194
Unsewered Localities Above 5,000 population	-	-	82,783	3%	88,432	96,968	111,830	127,239	158,399
Unsewered Localities Below 5,000 population	-	-	310,505	13%	331,694	370,269	413,331	461,402	515,062

**Table 5-5: Projected Flows and BOD Loads for WW Service Areas in Amman**

Service Area	2015	2020	2025	2030	2035
<b>Projected Wastewater Flow (m<sup>3</sup>/d)</b>					
Ain Ghazal	135,732	151,517	169,138	188,809	210,767
WZPS	18,423	20,565	22,957	25,627	28,607
Abu Nseir	2,305	2,573	2,872	3,206	3,579
Wadisseeer	3,824	4,269	4,765	5,319	5,938
Al-Jeeza WWTP	1,072	1,197	1,336	1,491	1,665
South Amman	14,384	16,057	17,925	20,009	22,336
Naour	2,019	2,254	2,516	2,809	3,135
Unsewered Localities Above 5,000 population	7,074	7,757	8,946	10,179	12,672
Unsewered Localities below 5,000 population	26,535	29,621	33,065	36,911	41,204
<b>Projected Wastewater Load (BOD Kg/d)</b>					
Ain Ghazal	110,288	123,115	137,433	153,416	171,259
WZPS	14,969	16,710	18,654	20,823	23,245
Abu Nseir	1,873	2,091	2,334	2,605	2,908
Wadi Es-Seer	3,107	3,468	3,872	4,322	4,825
Al-Jeeza WWTP	871	972	1,086	1,212	1,353
South Amman	11,688	13,047	14,565	16,259	18,149
Naour	1,641	1,831	2,044	2,282	2,548
Unsewered Localities Above 5,000 population	5,748	6,303	7,269	8,271	10,296
Unsewered Localities below 5,000 population	21,561	24,068	26,867	29,992	33,480

Table 5-6 below shows population projections and projected hydraulic flows and BOD loads for years 2015, 2025, 2035 for all unsewered localities in the served areas within Amman governorate.

**Table 5-6: Projected Population, Hydraulic Flows, and BOD Loads for Unsewered Areas within Served Areas and Unsewered Localities within the Amman Governorate**

District	Locality	Population (2012)	Projected Population			Projected flow (m <sup>3</sup> /day)			Projected BOD Load (kg/day)		
			2015	2025	2035	2015	2025	2035	2015	2025	2035
Quaismeh	Um Qsair, Moqabaleen	32,794	34,510	37,571	40,905	2,761	3,006	3,272	2,243	2,442	2,659
Quaismeh	Khreibet Essooq, Jawa, Yadoodeh	75,755	79,719	86,791	94,491	6,377	6,943	7,559	5,182	5,641	6,142
Sahab	Khashafiyet Shamalyeh	5,415	5,698	6,204	6,754	456	496	540	370	403	439
Sahab	Abdaliyyeh	8,324	8,760	9,537	10,383	701	763	831	569	620	675
Um El-Basatien	Um El-Basatien	19,666	20,695	22,531	24,530	1,656	1,802	1,962	1,345	1,465	1,594
Hesban	Rawdhah	5,902	6,211	6,762	7,362	497	541	589	404	440	479
Na'oor	Na'oor	6,493	6,833	7,439	8,099	547	595	648	444	484	526
Na'oor	Binayat	7,936	8,351	9,092	9,899	668	727	792	543	591	643
Na'oor	Um El-Sumaq	6,890	7,251	7,894	8,594	580	631	688	471	513	559
Wadisseer	Badr Jadedda	12,798	13,468	14,662	15,963	1,077	1,173	1,277	875	953	1,038
Wadisseer	Marj Elhamam	26,900	28,307	30,819	33,553	2,265	2,466	2,684	1,840	2,003	2,181
Wadisseer	Wadisseer	108,795	114,487	124,644	135,703	9,159	9,972	10,856	7,442	8,102	8,821

## Identification of Wastewater Service Needs Through 2035

### Ain Ghazal:

Service coverage within the Ain Ghazal service area is 98.5% with a population of about 24,000 not currently served within the Ain Ghazal pre-TP service area. Most of the unsewered areas are in Hay al-Sahaba and Marj al-Hamam.

Certain improvements were also identified giving an immediate priority to replacing about 11.5 km of trunk sewer lines currently reaching their capacities. Additional 54 km need to be replaced between 2015 and 2035.

### WZPS Service Area in Amman:

The current service coverage within WZPS service area in Amman is 85.8% with a population of about 29,460 not served within this service area. Most of the unsewered areas are in Shafa Badran, Marka and Nasr, and Jubeiha.

A total length of 25 km of main sewers in WZPS service area requires immediate improvement, whereas an additional 22 km need to be replaced between 2015 and 2030.

### **Wadisseeer Service Area (WSTP):**

A total length of 1.8km of main sewers in Wadisseeer service area requires improvement by 2020 (WIP) whereas an additional 8.4 km of main servers need to be replaced between 2015 and 2030.

### **South Amman (SATP) Service Area:**

A total length of 5.9km of main sewers in SATP service area needs improvement as their capacity is reached in 2015 (WIP) whereas an additional 37 km will reach their capacities by 2030.

### **Abu Nseir:**

Abu Nseir wastewater system serves 49% of Abu Nseir area. The unsewered population within the system is 30,052. Due to the health and environmental concerns caused from the WWTP effluent which caused pollution of domestic wells in Birien (Zarqa) in some incidents; a decision was made to stop all new connections to the WWTP service area. Proposal that is being considered by WAJ and Miyahuna is to divert wastewater loads to Samra WWTP through WZPS. The diversion (main sewer pipe) near Abu Nseir WWTP had been proposed to divert most of the flows in that system to WZPS system. The new system will require a lifting station in Abu Nseir WWTP, 2 Km pumping main and 12 Km gravity main to transfer wastewater loads to As Samra. Total approximate cost of 10 million JD.

Additionally, the total length of proposed pipe replacements in the four catchment areas in Amman (AGTP, WZPS, WSTP, and SATP service areas) is 165 km as shown in Table 5-7. Some short segments, which have sufficient capacity but are between two undersized pipes, are included in the improvement list. The proposed improvements to the Amman main sewers in the five-year intervals up to year 2035 design horizon are summarized in Table 5-8.

No improvements needed for Al-Jeeza system. The designed Naour system is also adequate to receive the 2035 peak flows.

**Table 5-7: Summary of Proposed Improvements to Sewer Main in Meters (m)**

Service Area	Year						Total
	2010	2015	2020	2025	2030	2035	
AGTP	11,460	13,800	5,182	25,787	814	8,026	65,067
WZPS	24,907	14,488	6,123	0	1,679	0	47,196
WSTP	0	0	1,832	8,426	0	0	1,259
SATP	0	5,855	0	0	0	36,934	42,789
Total	36,367	34,143	13,137	34,213	2,493	44,959	165,312

Furthermore, estimates were made for servicing unsewered localities with a population of more than 5,000.

**Table 5-8: Identified Localities with a Population Exceeding 5,000 in Amman Governorate**

District	Locality	Current Unsewered Population (2012)	% of Governorate Population
Quaismeh	Um Qsair, Moqabaleen	32,794	1.33
Quaismeh	Khraibet Essooq, Jawa, Yadoodeh	75,755	3.06
Sahab	Khashafiyet Shamalyyeh	5,415	0.22
Sahab	Abdaliyyeh	8,324	0.34
Na'oor	Um El-Basatien	5,902	0.24
Na'oor	Rawdhah	6,493	0.26
Na'oor	Binayat	7,936	0.32
Na'oor	Um El-Sumaq	6,890	0.28
Wadisseer	Badr Jadedea	12,798	0.52
Wadisseer	Marj Elhamam	26,900	1.09
Wadisseer	Wadisseer	108,795	4.4

The estimated costs for the improvement and the sewerage extension networks in the Amman catchment areas are shown in Table 5-9, whereas Table 5-10 shows cost estimates for unsewered areas and localities in Amman governorate.

**Table 5-9: Cost Estimate for Wastewater Service Needs in Amman**

Service System	Item	Investment Cost (Million JD)		
		Immediate (2013-2015)	2015-2025	2026-2035
Ain Ghazal	Improvements of existing sewer network	11.2	13.7	4.0
WZPS service Area	Improvements of existing sewer network	17.5	2.7	0.7
Wadisseeer Service Area	Improvements of existing sewer network		4.5	
Wadisseeer Service Area	Wadi Es-Seer WWTP	11.8	26.1	
South Amman Service Area	Improvements of existing sewer network	2.6		16.4
	Annual program for Improvements of existing sewer network	3.66 yearly (2015-2035)		
Unsewered localities Abou Nsair	Diversion of Abu Nsair WWIP to WZPS system	10.0		
	Construction of wastewater collection system and house connections		12.1	
Unsewered localities in Ain Ghazal	Construction of wastewater collection system and house connections	2.6	6.4	
	Phase 1 (immediate): Hay al-Sahaba & Marj al-Haman			
	Phase2(2025): Abu Alanda and al-Queisma			
Unsewered localities in WZPS service Area	Construction of wastewater collection system and house connections	4.5	12.1	
	Phase 1 – Shafa Badran			
	Phase 2 – Marka and Nasr			
<b>Governorate Total</b>				
Capital Costs		<b>60.2</b>	<b>77.6</b>	21.1
Yearly Expansion Programs		2.3 yearly (2015-2035)		

**Table 5-10: Cost Estimate for Wastewater Service Needs for Unsewered Areas and localities > 5,000**

District	Locality	Investment Cost (Million JD)		
		Immediate (2013-2015)	2015-2025	2026-2035
Quaismeh	Um Qsair, Moqabaleen	-	22.6	-
Quaismeh	Khraibet Essooq, Jawa, Yadoodeh	-	52.3	-
Sahab	Khashafiyet Shamalyeh	-	-	4.0
Sahab	Abdaliyyeh	-	-	6.3
Na'oor	Um El-Basatien	-	-	14.8
Na'oor	Rawdhah	-	-	4.5
Na'oor	Binayat	-	5.5	-
Na'oor	Um El-Sumaq	-	4.8	-
Wadisseer	Badr Jadedda	-	8.8	-
Wadisseer	Marj Elhamam	-	18.6	-
Wadisseer	Wadisseer	-	75.5	-
WWTP for Khashafiyet Shamalyeh, Abdaliyyeh Rawdhah, Um El-Basatien				4.9
Capital Costs		-	<b>188.1</b>	<b>34.5</b>
Grand Total for Tables 9 and 10		<b>60.2</b>	<b>265.7</b>	<b>55.6</b>

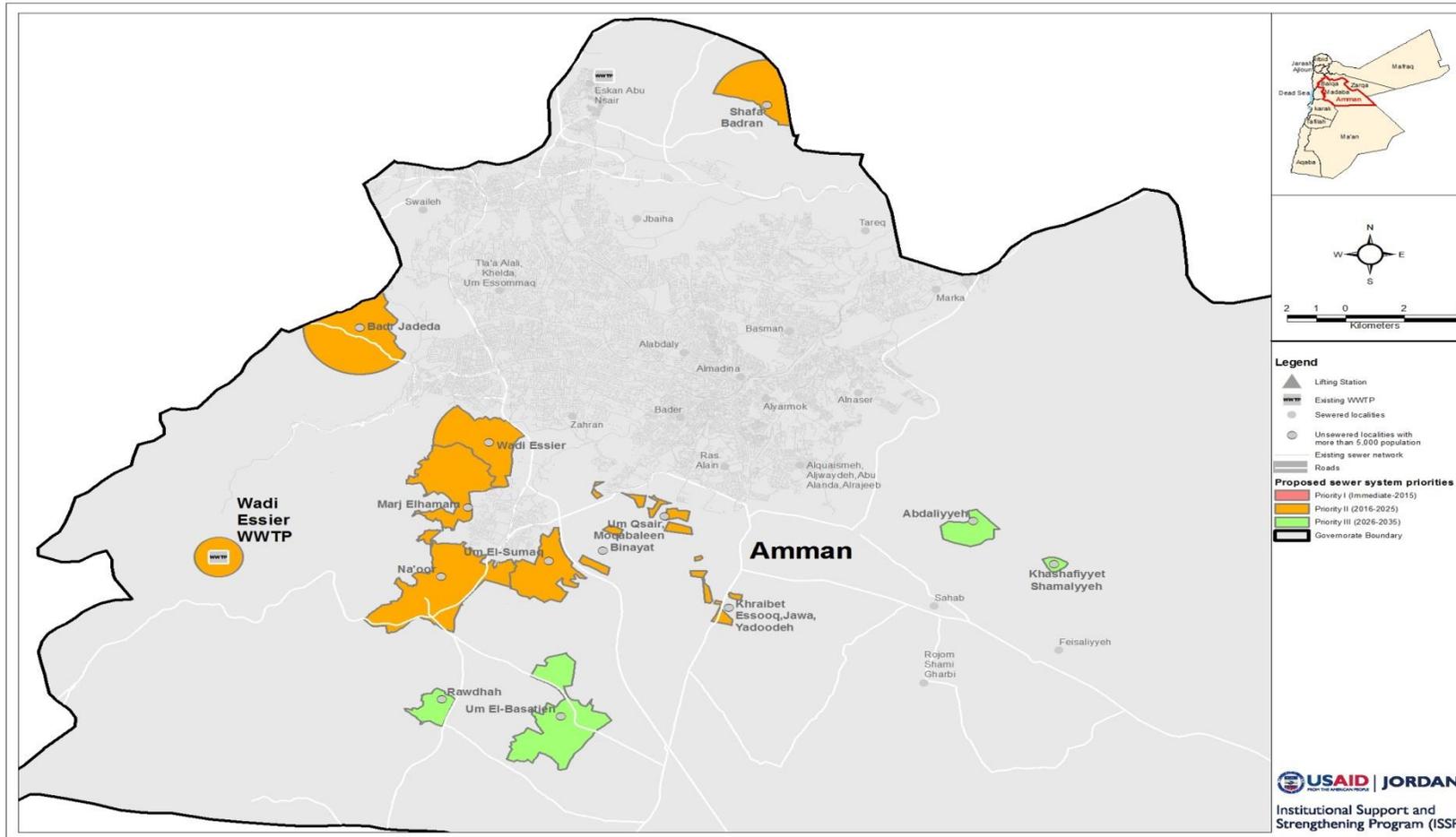


Figure 5-4: Proposed system priorities in Amman governorate

# 6 BALQA

## Summary of Wastewater Assessment

Balqa Governorate has a current population of 428,000 (2012) which is projected to grow to 671,101 in 2035, an increase of 57% over the next 23 years. The population is distributed over 80 localities of which 17 have a population of 5,000 or more with a combined population of 328,800 (77% of the governorate population). The remaining 63 localities have population less than 5,000 with a total of 99,200 (23% of the governorate population). Currently, 11 localities are served by wastewater collection systems while the remaining 69 are served by septic pits.

Within the sewered localities collectively only 184,000 people are connected to the sewer system which represents 43% of the total governorate population. There are 4 existing wastewater treatment plants (including 1 septage plant in the Jordan Valley) with total design capacity to serve 308,300 people which therefore have available treatment capacity for additional 124,300 people.

Based on the projected population of 555,100 by year 2025 and 678,000 by year 2035, the following wastewater systems and treatment needs are estimated (including service needs for areas connected to the Balqa system from Amman with total current served population of 64,000 projected to 94,600 people in 2035):

	Immediate (to 2015)	Year 2025	Year 2035
Needs	<ol style="list-style-type: none"> <li>Expansion of WWTPs</li> <li>Replacement of old networks</li> <li>Upgrading of lifting station (Ain Basha)</li> <li>Adding odor control system (Ain Basha)</li> <li>Maintenance of existing networks</li> </ol>	<ol style="list-style-type: none"> <li>Expansion of WWTPs</li> <li>Additional wastewater collection and treatment systems for 105,000 people</li> <li>Septage wastewater treatment for 163,100 people</li> </ol>	<ol style="list-style-type: none"> <li>Additional (between 2025-2035) wastewater collection and treatment systems for 231,300 people</li> <li>Septage wastewater treatment for 35,000 people (for localities of population less than 5,000)</li> </ol>
Estimated Costs	<ol style="list-style-type: none"> <li>6.7 million JDs</li> <li>9.3 million JDs</li> <li>1 million JDs</li> <li>1 million JDs</li> <li>0.5 million JDs</li> </ol>	<ol style="list-style-type: none"> <li>9.1 million JDs</li> <li>6.5 million JDs</li> <li>17 million JDs</li> </ol>	<ol style="list-style-type: none"> <li>58 million JDs</li> <li>4 million JDs</li> </ol>

A summary of estimated costs to cover the expansion of WWTPs and network expansion for years 2015, 2025, and 2035 are shown in the following table:

<b>Governorate Total (MJOD)</b>			
<b>Priority</b>	<b>2012-2015</b>	<b>2016-2025</b>	<b>2026-2035</b>
<b>Capital Costs</b>	<b>18.5</b>	<b>32.6</b>	<b>62</b>
<b>Yearly Expansion Programs</b>	<b>0.36 yearly</b>		

Details of the analysis of the existing situation with respect to wastewater collection and treatment and needed improvements for the future (up to 2035) with associated investment costs are presented in the following sections.

## **Introduction**

Balqa Governorate is located in the Central region of Jordan which also includes Amman, Zarqa and Madaba Governorates. Balqa sits on the Western side of the region and has an international border with Palestine. Current population of the governorate is 428,000 which is estimated to grow to 671,101 in 2035. It has a total area of 1,119 km<sup>2</sup> (1.3% of Jordan's area) with an average population density of 382persons/km<sup>2</sup>.

The governorate has 80 localities distributed on 5 districts:

- Salt Qasabah: includes Salt Qasabah, Al-Ardah, Allan and Zai, and Ira and Yargha sub-districts
- Shoonah Janoobiyah District
- Dair Alla District
- Ain Albasha District
- Mahes and Fuhais District

Figure 6-1 below shows the governorate districts and localities.

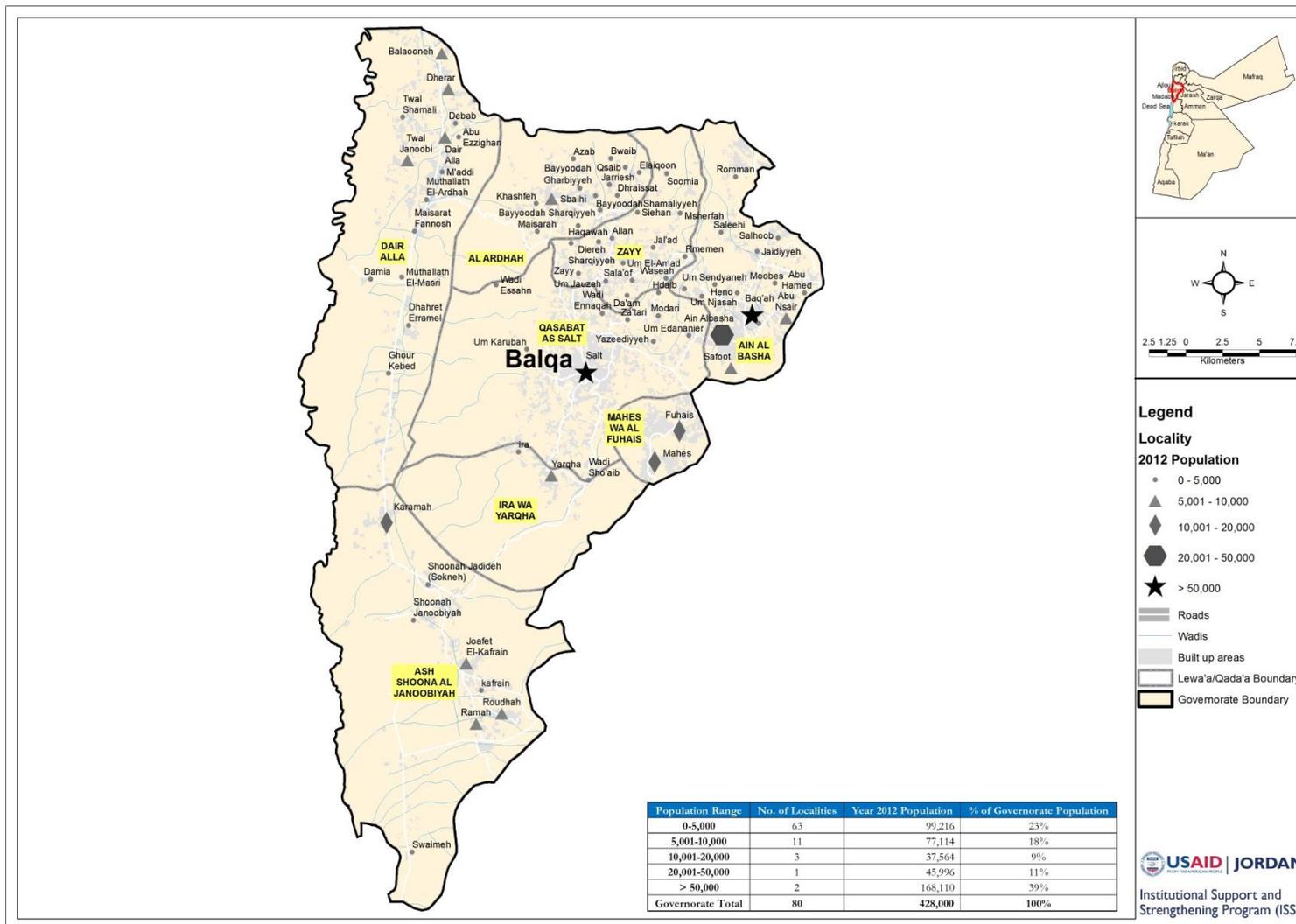


Figure 6-1: Balqa Governorate Districts and Localities

## Wastewater Service Areas

The existing sewer service areas cover 8 localities within three districts: Salt Qasabah, Ain Albasha and Mahes and Fuhais. The sewer systems within Balqa governorate are served through three WWTPs; Salt WWTP, Baqa'a WWTP and Fuhais WWTP. One Septage WWTP is located in Dair Alla District and serves localities within the District through wastewater tankers.

**Salt:** Salt City is the biggest locality within the governorate with a total population of 90,865 (21% of the governorate population). The estimated population connected to this service system is 59,000 (14% of the governorate population). The system is connected to Salt WWTP through one major interceptor with a diameter of 500mm. The total length of the system is about 183km with sewer diameters ranging from 200mm up to 500mm.

**Ain Albasha:** The sewer system serves Ain Albasha, Safoot, Baq'ah, Um Edananier, Shewahi El-Gharbi, Abu Hamed, and Salhoob localities within Ain Albasha District. The estimated number of connected population is about 102,000 (24% of the governorate population) assuming 50% coverage in Ain Albasha and Safoot, and 90% coverage in Baq'ah. Ain Albasha system is connected to Baq'ah WWTP. Part of the sewer system serves Sweileh and Kmaaliyyah Localities in Amman with a total current population of 64,000 (2012); both are located within Amman Governorate. The system has one lifting station which is connected to Baq'ah WWTP through a 600mm pressure main.

**Fuhais and Mahes:** The sewer system serves Fuhais and Mahes localities with an estimated coverage of 65%. Total estimated connected population is 18,000 out of 27,540 the total localities population. The system is connected to Fuhais WWTP which is located in the central waste area between the two localities. The system has one lifting station to serve areas within Fuhais locality.

The sewer systems within the governorate contain one locality that is connected to a sewer system that flows into a WWTP located in Amman governorate. The locality is Karet Abu Nsair and is connected to Abu Nsair WWTP which is located within Amman Governorate and is operated by Miyahuna. This locality has a total current population of 6,945. Estimated number of connected population is 3,470 (50% coverage within the locality).

List of served localities is shown in Table 6-1.

**Table 6-1: Served Localities in Balqa**

District	Localities	Population 2012	Estimate Served Population	System
Salt Qasabah	Salt	90,865	59,000	Salt sewer
Ain Albasha	Ain Albasha	45,996	23,000	Ain Albasha
Ain Albasha	Safoot	9,156	4,578	Ain Albasha
Ain Albasha	Um Edananier	886	443	Ain Albasha
Ain Albasha	Moobes	3,327	1,664	Ain Albasha
Ain Albasha	Shewahi El-Gharbi	2,787	1,394	Ain Albasha
Ain Albasha	Salhoob	2,490	1,245	Ain Albasha
Ain Albasha	Abu Hamed	1,075	538	Ain Albasha
Ain Albasha	Baq'ah	77,245	69,520	Ain Albasha
Ain Albasha	Salhoob	2,490	1,245	Ain Albasha
Ain Albasha	Karet Abu Nsair	6,945	3,470	Abu Nsair WWTP  (Amman System)
Mahes & Fuhais	Mahes	14,383	9,349	Fuhais and Mahes
Mahes & Fuhais	Fuhais	13,157	8,552	Fuhais and Mahes
<b>Total Population Served</b>		<b>184,000</b>		
<b>Total Governorate Population</b>		<b>428,000</b>		
<b>% Served</b>		<b>43%</b>		

## Wastewater Treatment

The governorate has 4 operating WWTPs, 3 of which are connected to sewer systems and one is a septage WWTP which receives wastewater loads from tankers in the Jordan valley area.

**Salt WWTP:** The treatment plant is located to the south of Salt locality. It was built in 1981 and was upgraded in 2005 to extended aeration and expanded with total capacity of 7,700m<sup>3</sup>/d. The treatment plant serves the Salt locality only with a total current load of 6,529m<sup>3</sup>/d, which is about 85% of the design hydraulic load. The plant has a biological design load of 4,620kg/d and received BOD load of 3,839kg/d in 2012 (83% of the design BOD load). The plant currently serves an approximate population of about 59,000 but designed for 71,000 people.

**Baq'ah WWTP:** The plant is located to the north of Ain Albasha locality and serves Ain Albasha, Safoot, Baq'ah, Um Edananier, Shewahi El-Gharbi, Abu Hamed, and Salhoob in addition to part of Sweileh and Kamaliyyah localities in Amman. It was built in 1987 and was upgraded in 1998 with a total capacity of 14,900m<sup>3</sup>/d. The treatment process is that of trickling filters. The plant operates at

79% of the hydraulic design capacity with current average wastewater hydraulic load of about 11,700m<sup>3</sup>/day. The design biological load is about 11,920kg/d while the plant receives an average BOD load of 7,160 kg/d. The plant currently serves an approximate population of about 102,000 within Balqa Governorate. As for Number of connected population from Amman governorate, the estimated number in 2008 was about 67,000 and is projected to about 65,000 in 2012. Which gives a total served population of 167,000 whereas designed for 183,300 people.

**Fuhais WWTP:** The plant is located in Fuhais and was built in 1997. The treatment process contains trickling filters and activated sludge. The WWTP serves Fuhais and Mahes localities with a design capacity of 2,400m<sup>3</sup>/day. The plant operates at 96% of the hydraulic design capacity with current average wastewater hydraulic load of about 2,300m<sup>3</sup>/day. The design biological load is about 2,390kg/d while the plant receives an average BOD load of 1,224 kg/d (51% of the design capacity). The plant currently serves approximate population of about 18,000people and designed for 36,000.

**Tal Al Mantah WWTP:** The plant is located in Dair Alla District and serves the Jordan Valley areas. It is a septage plant that receives wastewater loads through tankers. The treatment process contains trickling filters and activated sludge with an overall capacity to receive hydraulic load of 400m<sup>3</sup>/d and a biological load of 800kg/d. The plant currently receives a hydraulic load of 365m<sup>3</sup>/d (91% of the design capacity) and biological load of 570kg/d (71% of the design capacity). In terms of people, the design capacity is for 18,000.

Existing Wastewater systems in Balqa Governorate are shown in Figure 6-2

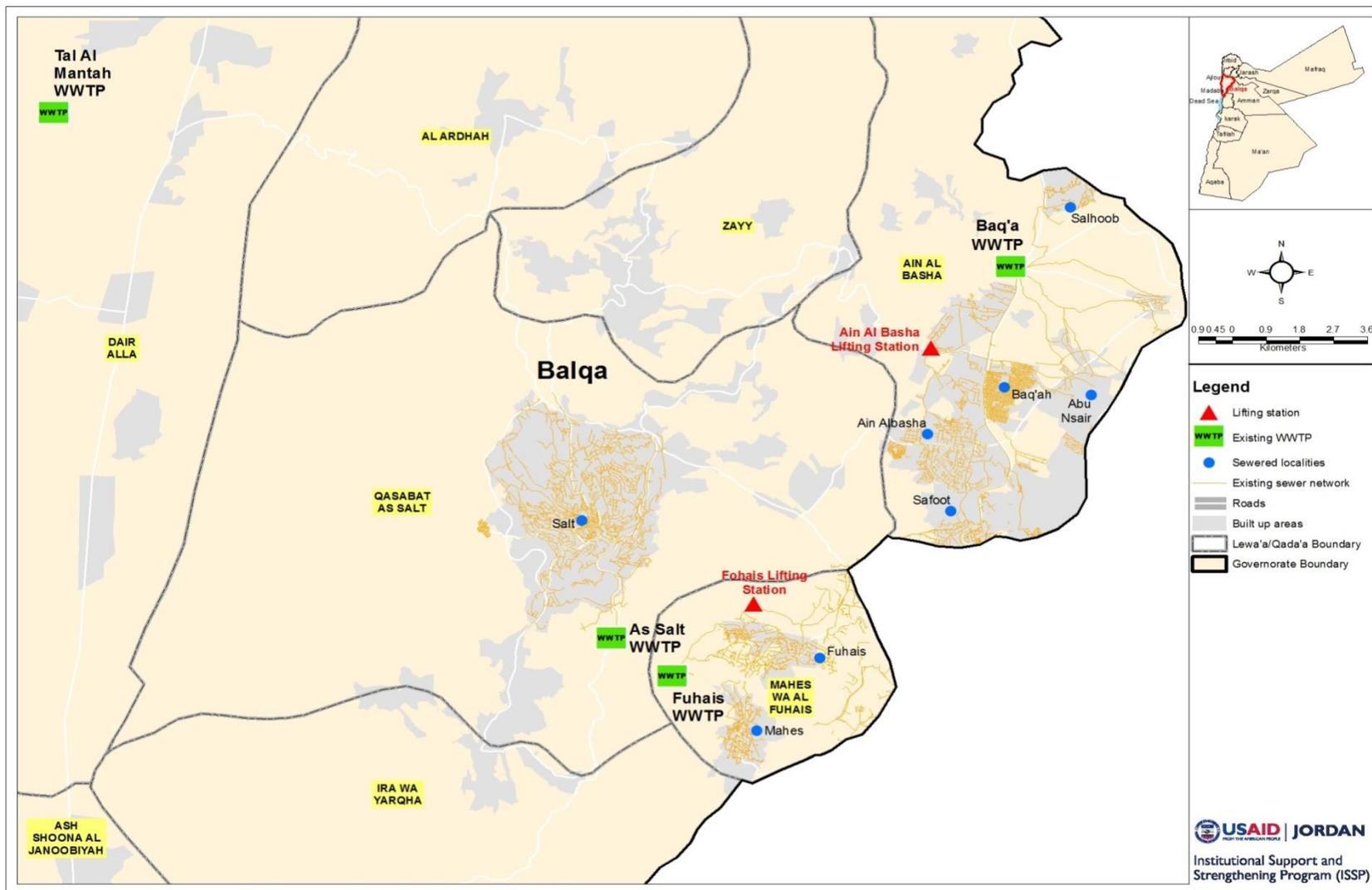


Figure 6-2: Existing Wastewater systems in Balqa governorate

## Unsewered Areas:

Wastewater service systems serve the eastern part of the governorate to cover part of the highlands. The Jordan Valley areas (Shoonah Janoobiyah and Dair Alla Districts) do not contain any sewer system and are served by septic pits with wastewater transferred by tankers to one septage WWTP located in Dair Alla District within the Jordan Valley. Table 6-2 below gives a list of the unsewered districts and their current population:

**Table 6-2: Unsewered Districts within Balqa**

District/Sub district	Current unsewered Population (2012)	% of Governorate Population
Salt Qasabah / Al-Ardha	12,090	3%
Salt Qasabah / Allan & Zayy	17,300	4%
Salt Qasabah / Ira & Yargha	10,690	2%
Shoonah Janoobiyah	47,890	11%
Dair Alla	57,440	13%

In addition to that, some localities with population of less than 5,000 within the served districts are not covered with sewer systems. Total estimated number of unsewered population exceeds 244,000 (57% of the total governorate population) including the unsewered population within the service areas of sewer systems.

In this report, localities above 5,000 population are considered for assessment as to their sewer service needs. Total population within these localities is about 64,630 (15% of the governorate population).

Unsewered Localities in Balqa Governorate are shown in Figure 6-3

WAJ undertook in 2009 a feasibility study funded by the USTDA to serve new localities to the north east of Salt. The study proposed a new WWTP close to King Talal Dam Area with a capacity of 6,600m<sup>3</sup>/d. The service area will include 20 localities with less than 5,000 each. Total population to be served, however, is about 26,000.

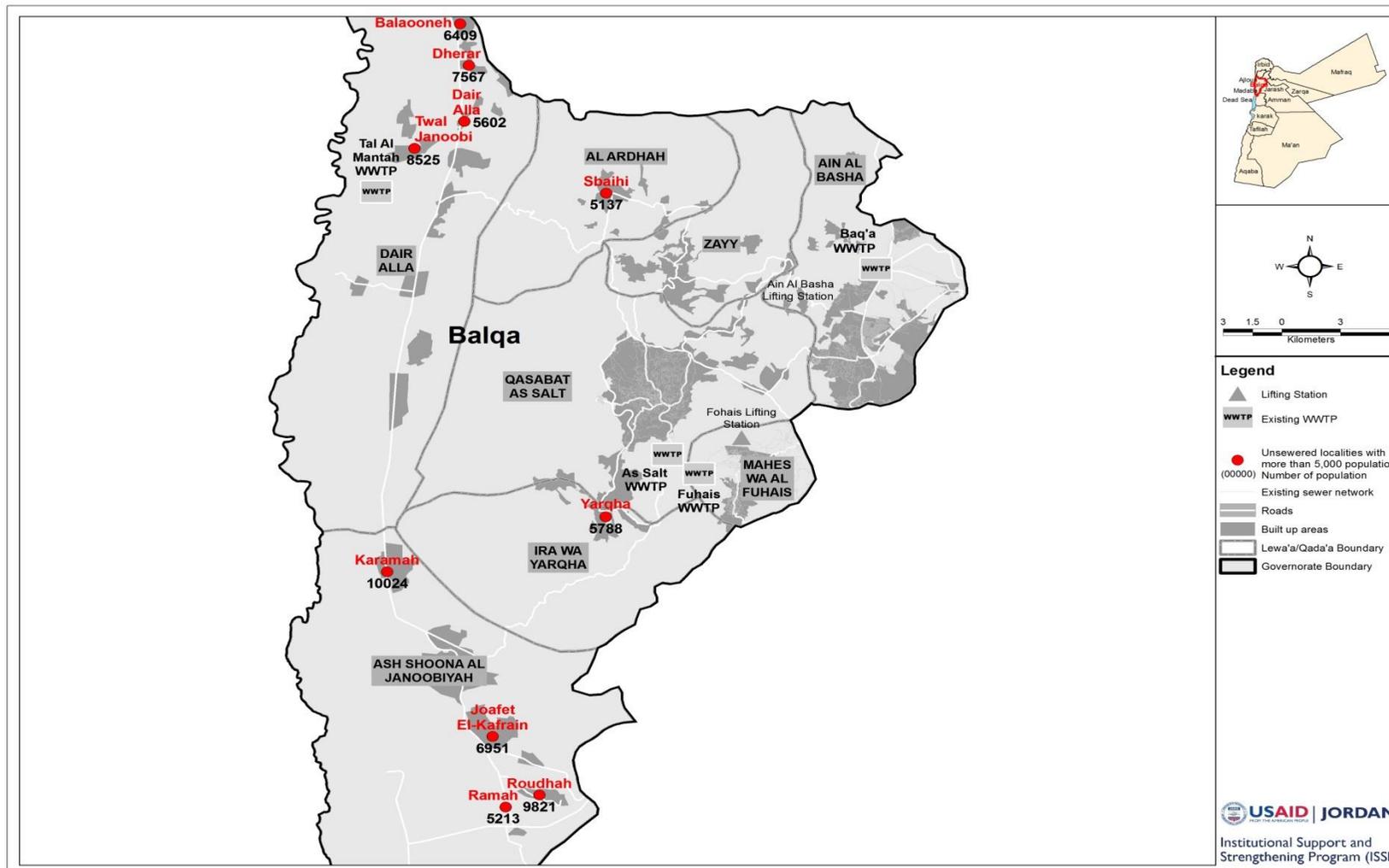


Figure 6-3: Unsewered localities in Balqa Governorate

## Projected Wastewater Loads

Table 6-3 below shows the population projections for each of the currently served population as well as those living in unsewered areas.

**Table 6-3: Population Projections for Balqa**

Service System	WWTP	Estimated Population Coverage (2012)	% of total Gov. Population	Projected Population				
				2015	2020	2025	2030	2035
Salt	Salt WWTP	59,000	14%	62,648	69,237	76,519	84,566	93,460
Ain Albasha*	Baq'ah WWTP	102,000	24%	108,307	119,698	132,287	146,200	161,576
Fuhais and Mahes	Fuhais WWTP	17,901	4%	19,008	21,007	23,216	25,658	28,357
Unsewered within Salt System	-	36,700	9%	38,969	43,068	47,597	52,603	58,136
Unsewered within Ain Albasha System	-	57,350	13%	60,896	67,301	74,379	82,201	90,847
Unsewered within Fuhais and Mahes System	-	9,639	2%	10,235	11,311	12,501	13,816	15,269
Unsewered Localities Above 5,000 population	-	64,628	15%	68,624	75,842	83,818	92,633	102,376
Unsewered Localities below 5,000 population	-	80,782	19%	85,777	94,799	104,769	115,787	127,965

\*Excluding connected population from Amman

The above population figures were used to develop the wastewater flows and biological loads projections shown in table 6-4. The table shows:

- Salt WWTP will be able to accommodate projected biological loads resulting from population growth within the current service areas only up to 2020. If it is assumed that additional areas within Salt locality to be served, which is likely the case, the plant will reach the BOD design capacity by 2015. In terms of hydraulic loads, estimated population based on BOD loads received from WAJ gave lower wastewater flows if this was estimated based on 80l/cap/day. The plant currently receives approximately

6,500m<sup>3</sup>/d compared to the calculated figure of 4,800m<sup>3</sup>/d (based on an estimated population of 59,000).

- Baq’ah WWTP: The plant is now operating within hydraulic and biological design limits. Considering the population growth within the current service area (including sewer areas in Amman that flows to the plant), and increasing service within the locality (current is 50% for Ain Albasha District) the plant will exceed the design capacities by 2015.
- Fuhais WWTP: Based on BOD projected loads for current system and considering system expansion to cover new areas in Fuhais and Mahes Localities, the plant will receive BOD loads exceeding the design capacity in 2030. The projected total BOD loads for 2030 is 2,500kg/d while the plant BOD design capacity is 2,400kg/d.

**Table 6-4: Projected Wastewater flow and BOD Loads in Balqa**

Service Area	2015	2020	2025	2030	2035
<b>Projected Wastewater Flow (m<sup>3</sup>/d)</b>					
Salt	5,012	5,539	6,122	6,765	7,477
Ain Albasha*	8,665	9,576	10,583	11,696	12,926
Fuhais and Mahes	1,521	1,681	1,857	2,053	2,269
Unsewered within Salt System	3,118	3,445	3,808	4,208	4,651
Unsewered within Ain Albasha System	4,872	5,384	5,950	6,576	7,268
Unsewered within Fuhais and Mahes System	819	905	1,000	1,105	1,222
Unsewered Localities Above 5,000 population	5,490	6,067	6,705	7,411	8,190
Unsewered Localities below 5,000 population	6,862	7,584	8,381	9,263	10,237
<b>Projected Wastewater load (BOD Kg/d)</b>					
Salt	4,072	4,500	4,974	5,497	6,075
Ain Albasha	7,040	7,780	8,599	9,503	10,502
Fuhais and Mahes	1,236	1,365	1,509	1,668	1,843
Unsewered within Salt System	2,533	2,799	3,094	3,419	3,779
Unsewered within Ain Albasha System	3,958	4,375	4,835	5,343	5,905
Unsewered within Fuhais and Mahes System	665	735	813	898	992
Unsewered Localities Above 5,000 population	4,461	4,930	5,448	6,021	6,654
Unsewered Localities below 5,000 population	5,576	6,162	6,810	7,526	8,318

\*Excluding connected population from Amman

## Identification of Wastewater Service Needs Through 2035

### Salt System:

The plant was upgraded in 2005 and currently plant receives 85% of the hydraulic capacity and about 83% of the biological capacity. Priority within this system should be allocated to expanding the sewer service to cover more areas within Salt locality and to commence working on plant upgrade which is needed to start by 2015. The plant shall be upgraded to receive additional loads forecasted up to 2025. Projected hydraulic load for 2015 assuming an increase in coverage area is 8,129m<sup>3</sup>/d and a corresponding increase in the projected BOD 6,600kg/d; these loads will result from an additional population of 100,000 to be connected within the service system. In 2025, this load is expected to reach about 9,900m<sup>3</sup>/d for hydraulic whereas about 8,000kg/d for BOD.

### Ain Albasha System:

The first priority within this system is the upgrading of the plant which will be receiving loads that exceed its design capacity by 2015. The estimated overall loads to be accommodated by 2015 are approximately 19,000m<sup>3</sup>/d for wastewater hydraulic load (current capacity is 14,900m<sup>3</sup>/d) and 15,300kg/d for BOD load (current capacity is 11,99kg/d), this load is resulted from about 230,000 connected population within Ain Albasha and some of Amman.

The sewer system covers large areas in within the district though average connectivity within Ain Albasha is around 50%. The system needs to be expanded after resolving the issue of the WWTP capacity in order to increase service coverage within the district.

Considerations shall be allocated for changing the plant location due to issues of the current location on a major highway which connects Amman and southern region to the northern region. The Odor problem is also a serious issue to be considered as the plant is adjacent to the district centre.

### Fuhais and Mahes System

The plant was built in 1997 to serve populations within two localities, Fuhais and Mahes. In terms of BOD load, the plant capacity is to serve a population of about 36,000. Taking into account the projected population for the current service area and assuming expansion of the sewer system to cover new areas within Fuhais and Mahis, the treatment plant will be able to accommodate wastewater loads until 2025. Investment is to be allocated to expand the service area by increasing coverage within the two localities which is currently about 65%.

### Unsewered localities with population more than 5,000

Unsewered localities with more than 5,000 population are mainly located within the Jordan Valley area in Dair Alla and Shoonah Janoobiyah Districts.

Two unsewered localities with populations of more than 5,000 are located in the highlands area: Sbaihi with a total current population of 5,140 and Yargha with a total current population of 5,800.

Table 6-5 below shows unsewered localities (with population of more than 5,000) and their service needs.

**Table 6-5: Unsewered Localities with more than 5,000 Population in Balqa**

District	Locality	Current Population	Projected Population (2035)	Collection Wastewater System estimated Length (km)	Wastewater Treatment Needed (m <sup>3</sup> /d)	Estimated Biological Loads (BOD, KG/d)
Al-Ardha	Sbaihi	5,140	8,140	16	650	530
Ira & Yargha	Yargha	5,800	9,170	18	740	600
Shoonah Janoobiyah	Karamah	10,024	15,879	30	1,270	1,040
Shoonah Janoobiyah	Roudhah	9,821	15,557	30	1,245	1,015
Shoonah Janoobiyah	Ramah	5,213	8,258	16	660	540
Shoonah Janoobiyah	Joafet El-Kafrain	6,951	11,011	21	880	720
Dair Alla	Dair Alla	5,602	8,874	17	710	580
Dair Alla	Twal Janoobi	8,525	13,504	26	1,080	880
Dair Alla	Dherar	7,567	11,987	23	960	780
Dair Alla	Balaooneh	6,409	10,152	20	820	660

As mentioned earlier, WAJ undertook a feasibility study to serve scattered localities with less than 5,000 population in 2009. This study will serve population of about 26,000 (6% of the governorate population), the overall cost of the project is 52 million JDs including WWTP and sewer system costs.

Table 6-6 below illustrates the estimated costs needed to implement required wastewater service needs to accommodate projected loads of the current systems and to expand the wastewater service area to cover localities with more than 5,000 population.

**Table 6-6: Cost Estimate for Wastewater Service Needs in Balqa**

Service System	Item	Investment Cost (Million JD)				
		Immediate (up to 2015)	2020	2025	2030	2035
Salt	Expansion of WWTP Phase1 (2025) : additional capacity of 2100m <sup>3</sup> /d (total needed capacity is 9,900m <sup>3</sup> /d) Phase2 (2035) : additional capacity of 2200m <sup>3</sup> /d (total needed capacity is 12,200m <sup>3</sup> /d)	2.3		2.4		
	Replace 30 Km of old pipes from 150mm to 300mm (160JOD/m)	4.8				
Ain Albasha*	Expansion of WWTP Phase1(2025) : additional capacity of 4,000m <sup>3</sup> /d (total needed capacity is 22,900m <sup>3</sup> /d)Phase2 (2035) : additional capacity of 4,800m <sup>3</sup> /d (total needed capacity is 27,700m <sup>3</sup> /d)	4.4		5.3		
	Adding odor control system to the WWTP	1.0				
	Replace 20 Km length of 200mm to 300mm or 400mm pipes (170JOD/m)	3.4				
	Replace 3 Km length of 300mm to 500mm pipes (200JOD/m)	0.6				
	Upgrading of lifting station (including land acquisition)	1.0				
Fuhais and Mahes	Expansion of WWTP – additional capacity of 1,200m <sup>3</sup> /d (Total capacity 3,500m <sup>3</sup> /d)			1.4		
	Maintenance of existing network	0.5				
	Annual Expansion program for wastewater collection and house connections expansion for the existing systems (Average yearly growth up to 2035) 1,200 people/yr @ 303JD/capita	0.36				
Unsewered localities below of population	Construction of wastewater collection: system and house connections Phase1 (2020): Yargha		4.0		46.5	

Service System	Item	Investment Cost (Million JD)				
		Immediate (up to 2015)	2020	2025	2030	2035
of more than 5,000	Phase2 (2030): Sbaihi, Karamah, Roudhah, Ramah, Joafet El-Kafrain, Dair Alla, Twal Janoobi, Dherar, and Balaooneh					
	Treatment Costs needed: Phase1 (2020): Yargha Phase2 (2030): Sbaihi, Karamah, Roudhah, Ramah, Joafet El-Kafrain, Dair Alla, Twal Janoobi, Dherar, and Balaooneh		1		11.5	
<b>Governorate Total</b>						
Capital Costs		18.5	5	9.1	58	
Yearly Expansion programs		0.36				

\* Including capacity requirements for connected population from Amman.

Figure 6-4 below illustrates needed investment in wastewater collection and treatment through 2035.

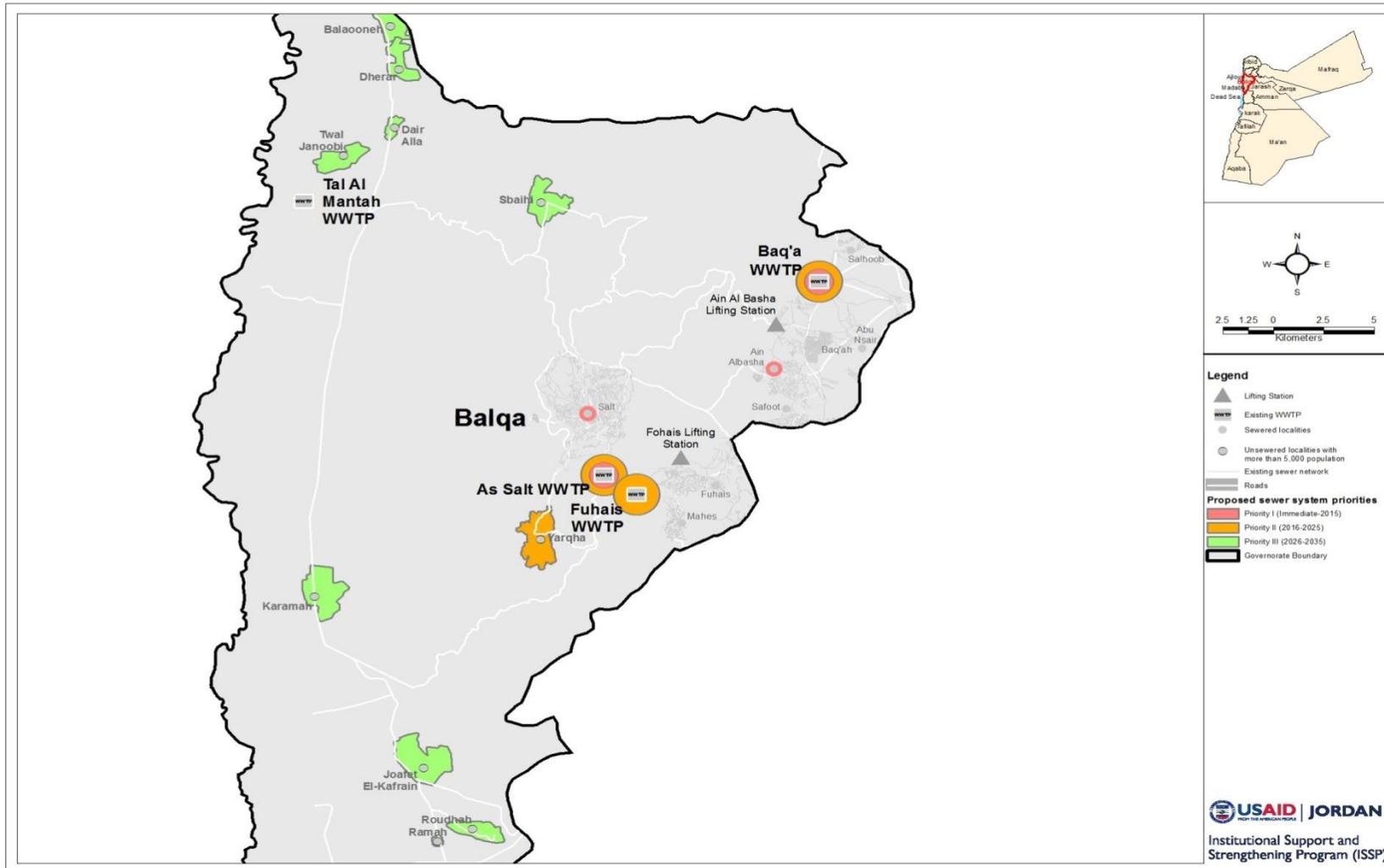


Figure 6-4: Balqa Governorate Investment Priorities

# 7 MADABA

## Summary of Wastewater Assessment

Madaba governorate has a current population of 159,700 which is projected to grow to 243,363 in 2035, an increase of 52% over the next 23 years. Madaba governorate has 73 localities in two districts: Madaba Qasabah, and Deeban. Qasabah district includes 4 sub districts containing 124,580 people or approximately 78% of the governorate population. Madaba Qasabah district has a projected population for year 2035 of 188,472. Deeban district which includes 3 sub-districts contains 35,120 population comprising 22% of the total population with a projected population for year 2035 of 53,132. Currently, the population provided with wastewater services is only in Madabah Qasabah and within an existing wastewater collection system serving the City of Madaba. The system currently receives flow from 51,900 people (60%) in Madaba city area through a sewer network of approximately 167 km of gravity sewers with no pumping stations. Parts of the city are not connected to the main system. Flow from these areas drain to septic tanks and is then discharged directly to the WWTP via tankers.

Madaba WWTP is located to the south-east of the city of Madaba near to the slaughter house and is an activated sludge plant with a design flow capacity of 7,600/day. The plant is currently receiving a flow of about 5,200 m<sup>3</sup>/ day and therefore has available capacity of 2,400 m<sup>3</sup>/day which could serve approximately 30,000 people in Madaba city .This needs additional investment for 103.5 km of sewer networks, and possibly upsizing parts of the sewer network to be implemented early in the second phase of priorities. This will increase the service coverage within Madaba WWTP service area to about 95% and will increase the governorate coverage to reach about 50% of the total population.

Expansion of the existing WWTP is envisaged at three stages for years 2015, 2025, and 2035. This is to cover projected populations for these yearsfor Madaba city.

Five localities were identified for future wastewater service with priorities considered. These localities are Ma'mounieh, Fisalieh, Deeban, Maieen, and Milah.

Other small localities with populations less than 5,000 will need to continue the current practice of discharging domestic wastewater flows to the septic pits if there were no records for health or water pollution problems.

Based on the projected population of 168561 by year 2015, 201804 by year 2025, and 241603 by year 2035, the following wastewater systems and treatment needs and costs are estimated:

	Immediate (to 2015)	Year 2025	Year 2035
Needs	1. Replacement of existing pipes	1. Additional wastewater collection system (125Km) to serve the unserved population within Madaba city. 2. Madaba WWTP stage I expansion 3. Collection (63Km) and treatment system serving new locality of Maieen 4. Collection (km) and treatment system serving new localities of Ma'monieh and Fisaliah	1. Madaba WWTP stage II expansion 2. Madaba wastewater collection system expansion (55km) 3. Collection (63Km) and treatment system serving new locality of Deeban 4. Collection (33Km) and treatment system serving new localities of Milah
Estimated Costs	1. 1.8 million JDs	1. 30.2 million JD 2. 1.25 million JD (stage 1) 3. 7.3 million JD (Collection & WWTP) 4. 11.5 million JD (collection system); 2.4 million JD (WWTP)	1. 1.9 million JD 2. 13.3 million JD 3. 5.2 million JD (collection system); 2.4 million JD (WWTP) 4. 6.5 million JD (collection system); 1.1 million JD (WWTP)

A summary of estimated costs to cover the expansion of the WWTP and network expansion for year 2015, and 2025, and 2035 are shown in the following table:

Governorate Total (MJOD)			
Priority	2012-2015	2016-2025	2026-2035
Capital Costs	1.8	52.65	30.3
Yearly Expansion Programs	0.3 yearly		

## Introduction

Madaba governorate, with Madaba city as the major urban center, is located south west of Amman city. The governorate is ranked eighth both in terms of population and area. It is bordered by Balqa governorate from the north, the capital governorate from the east, Karak governorate from the south, and the Dead Sea from the west. Ma'in village in Madaba is the site of a natural thermal waterfall. Its therapeutic effects are utilized by those with aching joints and skin irritations. A new tourist industry is growing around the site with a new hotel and spa.

The climate varies significantly within the governorate due to the difference in altitude of the governorate's regions; Madaba city is at 798 meters above sea level, while the Dead Sea is at approximately 300 meters below sea level, resulting in a significant difference in temperature between the two locations. The northern region of the governorate is agricultural, with a total area of 59 km<sup>2</sup> of fruit and olive farms.

The Governorate area is approximately 940 Km<sup>2</sup> and has a current population of 159,700 giving a population density of about 163 person /km<sup>2</sup>. The population is estimated to grow to 241,603 in 2035.

The governorate has two districts Madaba Qasabah, and Deeban. Madabah Qasabah has 4 sub districts namely Madaba Qasabah, Jrieneh, Maeen, and Fisaliah with 24 localities and a total population of 124,580 representing 78% of the governorate population. Deeban district has 3 sub-districts namely Deeban, Areedh, and Milah with 49 localities and a total population of 35,120 comprising 22% of the governorate. Madabah Qasabah district is about 47% of the governorate area while Deban district is about 53% of the governorate area. This indicates the variation in population density between the two districts. For Madabah Qasabah the population density is about 282 people/Km<sup>2</sup>, while for Deban it is about 71 people/ km<sup>2</sup>. Figure 7-1 shows the population distribution at the locality level.

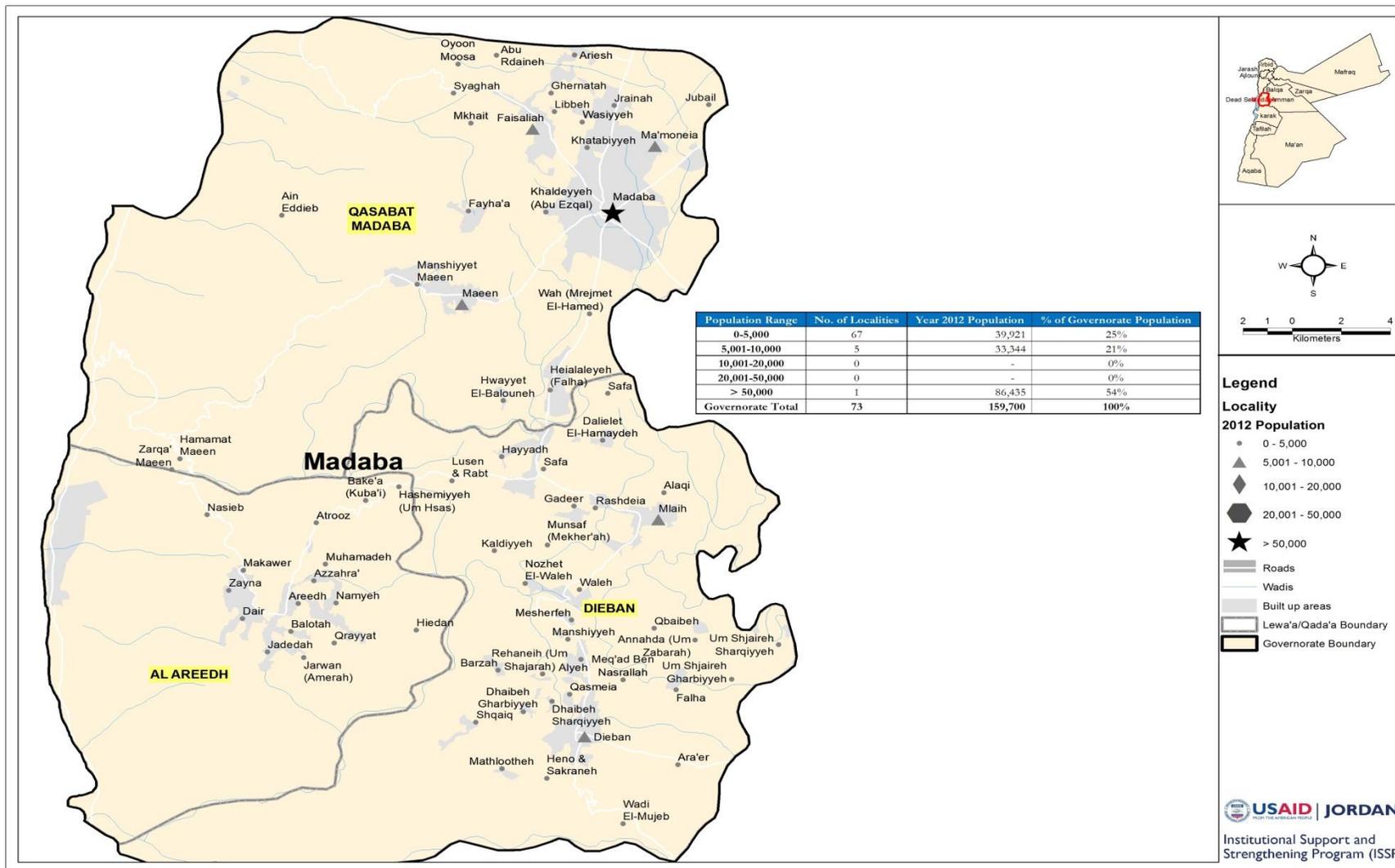


Figure 7-1: Madaba Governorate Districts and Localities

## **Water Supply Service:**

The governorate is served with water supply service through Walah and Heedan ground-water wells with the total quantity of water from Walah pump station to Madaba governorate currently being 1400 m<sup>3</sup>/hr. Water is pumped from Walah pump station to both Lebb pump station and to Theeban reservoir to supply Theeban district through Theeban pump station. Lebb Pump station pumps water to both Madaba reservoir in Madaba to supply Madaba city and other localities, and to Milah booster station which supplies Milah and Bani Hameedah villages. Water supply service effectively covers all localities in the governorate. The amount of per capita water supply is about 105 l/c/d.

## **Wastewater Service Area:**

The existing sewer service areas only cover localities within one district giving a total service coverage of about 54% of the governorate population. The sewer systems in the governorate are served through one WWTP, namely the Madaba WWTP.

### **Madaba Wastewater Service Area**

Madaba City, is the biggest locality within the governorate and is part of Madaba Qasabah sub-district. It has a population of 86,435 (54% of the governorate population). About 51,900 are served through the sewer system connected to Madaba WWTP. The system flows by gravity to two major collectors: one collector from north of Madaba city flows directly to the WWTP through a 500mm pipe; the second collector flows directly to the WWTP through another 500mm pipe. The collectors start with 200mm pipe and increase up to 500mm pipe. The wastewater network serving the area is about 167 Km with pipe diameters of 200mm and house connections of 150mm. Figure 7-2 shows the wastewater service area.

## **Wastewater Treatment:**

**Madaba WWTP:** The plant was constructed in 1989 to provide wastewater treatment through stabilization ponds. The Plant was replaced in 2003 by an activated sludge process with an average design capacity of 7,600 m<sup>3</sup>/day and a BOD load of 7,220 kg/d. The plant currently receives an average flow of 5,400 m<sup>3</sup>/day, which is approximately 72% of the design hydraulic load. In terms of biological load, the plant receives an average BOD load of 3,370 kg/d which is 47% of the BOD design load. The plant still has enough capacity to cover 95% of Madaba current population of 86,435. The unserved population of Madaba city is about 34,500 persons which will require approximately 103.5 Km of new sewer networks at an estimated cost of 21 million JD.

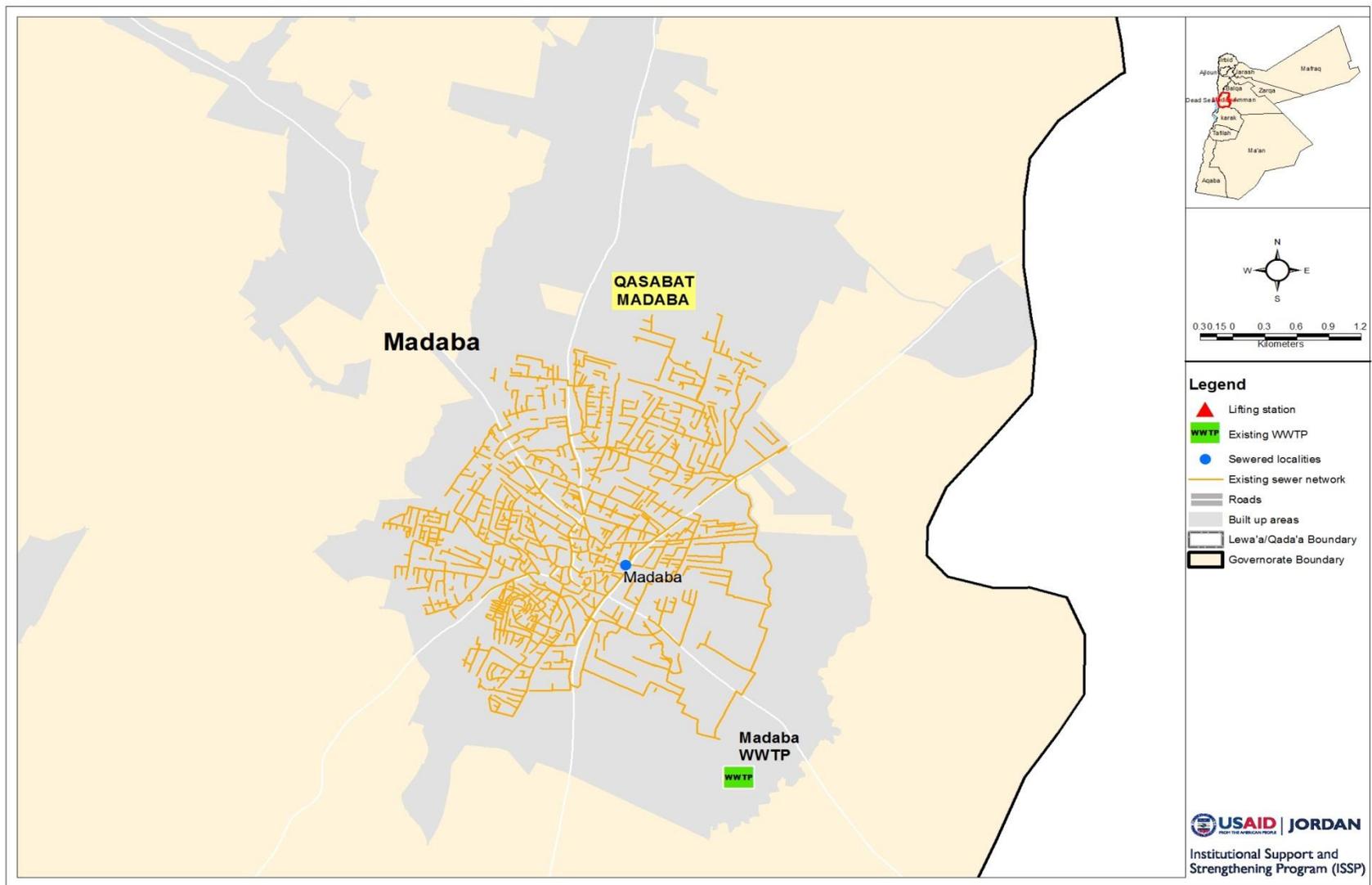


Figure 7-2: Existing Wastewater systems in Madaba governorate

## Unsewered Areas:

Areas that are not covered with sewer systems are served through septic pits that are likely not sealed. The population not covered with sewer systems is approximately 107,800 inhabitants, or 68% of the total population. About 34,500 (22% of the unsewered areas) are located within the Madaba system. The remaining population is distributed on small localities all over the governorate. The biggest 5 localities which have population of more than 5,000 constitute 21% of the governorate population: Ma'moneeh, Maieen, Fisaliah, Deeban, and Milah.

Other localities will continue to use septic pits as there is no history for water pollution or any health problems.

**Table 7-1: Unsewered localities with more than 5,000 population**

District	Locality	Current unsewered Population (2012)	% of Governorate Population
Madaba Qasabah	Madaba city	34,500	22%
Deeban	Ma'mounieh	6,380	4.0%
	Fisaliah	6,101	3.8%
	Maieen	6,550	4.1%
	Deeban	7,131	4.5%
	Milah	7,182	4.5%

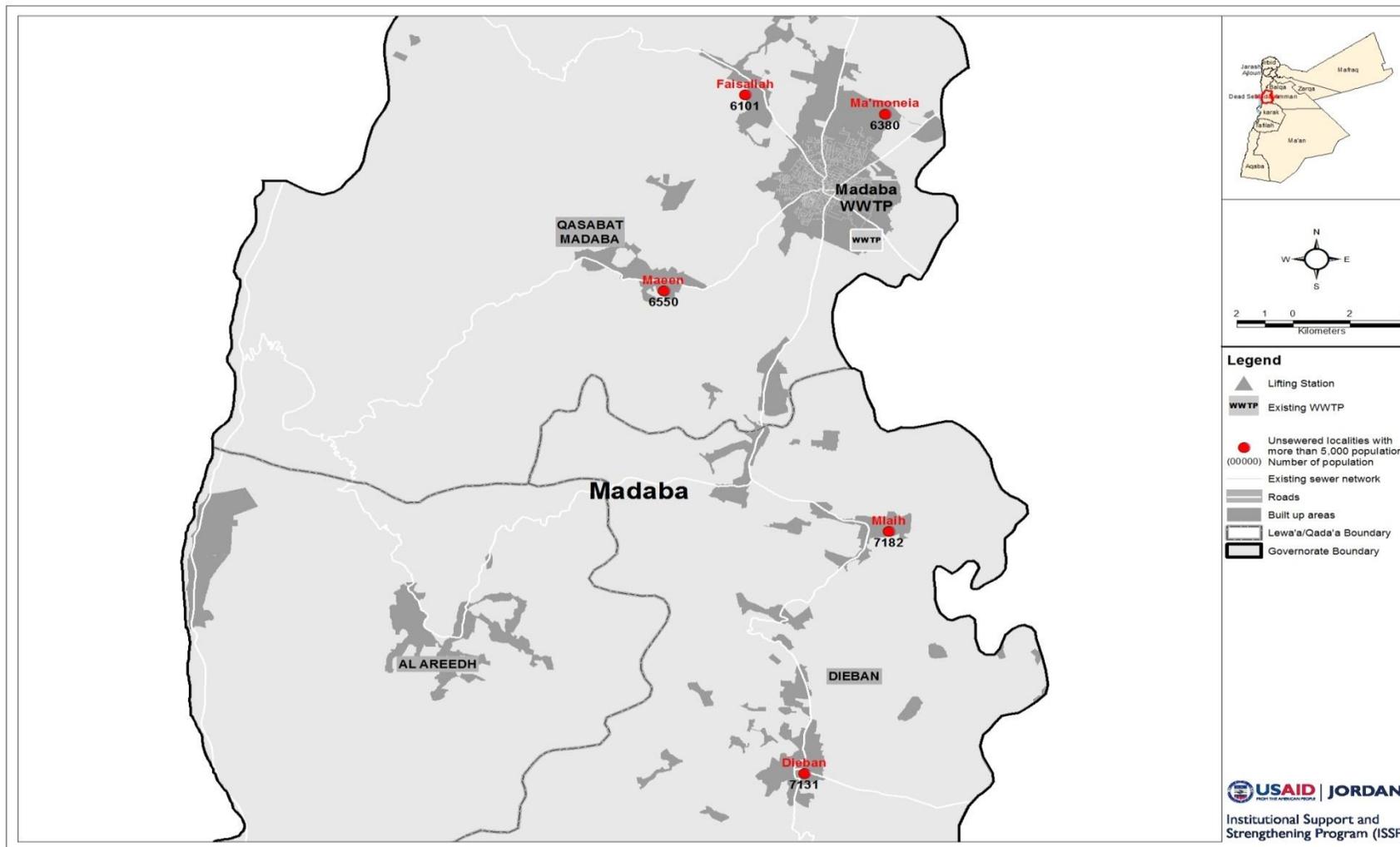


Figure 7-3: Unsewered Localities in Madaba Governorate

## Projected Wastewater Loads

Table 7-2 below shows the population projections for each of the current served population and unsewered areas. The population projection figures were used to estimate water and wastewater loads.

**Table 7-2: Population Projections in Madaba**

Service System	WWTP	Status	Served Population (2012)	Projected Population		
				2015	2025	2035
Madaba	Madaba WWTP	Existing	59,100	91,231	109,233	130,764
Ma'moneeh	-	Proposed	0	6,734	8,062	9,652
Maieen	-	Proposed	0	6,913	8,277	9,909
Fisaliah		Proposed	0	6,440	7,709	9,230
Deeban		Proposed	0	7,527	9,011	10,788
Milah		Proposed	0	7,580	9,075	10,865
Unsewered Localities below 5,000 population	-	-	0	133,367	159,669	191,159

The above population figures were used to develop the wastewater flows and biological loads projections shown in Table 7-3

**Table 7-3: Wastewater flows and biological loads projections in Madaba**

Service Area	2015	2025	2035
<b>Projected Wastewater Flow (m<sup>3</sup>/day)</b>			
Madaba	7,298	8,739	10,461
Ma'moneeh	539	645	772
Maieen	553	662	792
Fisaliah	515	617	738
Deeban	602	721	863
Milah	606	726	869
Unsewered Localities below 5,000 population	10,669	12,774	15,293
<b>Projected Wastewater load (BOD Kg/d)</b>			
Madaba	5,930	7,100	8,500
Ma'moneeh	438	524	627
Maieen	449	538	644
Fisaliah	419	501	600
Deeban	489	586	701
Milah	493	590	706
Unsewered Localities below 5,000 population	5,335	6,387	7,646

## Identification of Wastewater Service Needs Through 2035

### Madaba City

The current service coverage within the city is 68% with approximately 34,500 not served within the Madaba WWTP service area. Therefore serving unserved population within Madaba city is an urgent issue. The flow design capacity and design BOD load for the WWTP of Madaba is capable of taking the extra flows and BOD loads. The wastewater network extension to serve the targeted population is estimated to be 103.5 Km pipes with an estimated cost of 20.7 MJOD.

Madaba WWTP current capacity is sufficient to treat 7,400 m<sup>3</sup>/ day and will exceed this by 1,140 m<sup>3</sup>/day by 2025, and by 2860 m<sup>3</sup>/day by 2035 as indicated in Table 7-2. This Table also shows that Projected BOD load will also exceed the design capacity in 2035 by 18%. Therefore it is proposed to carry out expansion of the WWTP in two stages to reach a design flow capacity of 10,460 m<sup>3</sup>/d and a BOD load of 8,500 kg/day by year 2035.

Projected population, flow capacities, and BOD loads for Madaba city for the years 2015, 2025, 2035 require considerations for wastewater network expansions and Madaba WWTP expansion as well. This can be staged for year 2015, 2025, and 2035.

### **Madaba city 2012-2015:**

Based on adopted priority definitions, no immediate wastewater systems are envisioned for this period, although planning for extension of Madaba city wastewater systems in early 2016-2025 must start.

### **Madaba city 2016-2025:**

With existing design capacity of Madaba WWTP of 7,600 m<sup>3</sup>/day, it is envisaged that there is a need to expand Madaba WWTP by 1,140 m<sup>3</sup>/day, while sewer networks will need further expansion. The estimated length of the sewer system including the house connections is estimated to be 125km using 2.5 m network/person. The estimated network costs are (21.3+8.9) 30.2 million JD, and WWTP expansion cost is 1.25MJOD.

### **Madaba city 2026- 2035:**

Projected population for Madaba city of 130,764 in 2035 will result in wastewater flow of 10,461 m<sup>3</sup>/day and BOD load of 8,500 kg/d. With expanded stage I design capacity of Madaba WWTP of 8,740m<sup>3</sup>/day, it is envisaged that the WWTP will need to have a second expansion of 1,720 m<sup>3</sup>/day in stage II. The sewer networks will also need further expansion with an estimated length of additional sewer system including the house connections, being 55 km using 2.5 m network/person. The estimated network cost is (9.4+3.9) 13.3 million JD and WWTP costs 1.9 million JD.

### **Milah**

Milah is the second largest community in the governorate and is located approximately 25 km south east of Madaba city. Its current population is 7,182 which is projected to grow to 10,865 in 2035, and will result in a wastewater flow of 869 m<sup>3</sup>/day and BOD load of 706 kg/d in the year 2035. The estimated length of the sewer system including the house connections is 32.6 km using 3 m network/person. The estimated network cost is (4.6+1.9) 6.5 million JD and WWTP costs are 1.1 million JD.

### **Deeban**

Deeban is the third largest community in the governorate and is located 70 km south of Madaba city. It has a current population of 7,131 which is projected to grow to 10,788 in 2035 and will result in a wastewater flow of 863 m<sup>3</sup>/day and BOD load of 701 kg/d. The estimated length of the sewer

system including the house connections is 32.6 km using 3 m network /person. The estimated network cost is (4.6+1.9) 6.5 million JD and WWTP costs are 1.1 million JD.

### **Maieen**

Maieen is the fourth largest community in the governorate and is located 15km south west of Madaba city with a current population of 6,550 which is projected to grow to 9,900 in 2035, resulting in a wastewater flow of 792m<sup>3</sup>/day and BOD load of 644 kg/d. The estimated length of the sewer system including the house connections is 29.7km using 3 m network /person. The estimated network cost is (4.2+1.8) 6.0 million JD and WWTP costs are 1.3 million JD.

### **Ma'monieh**

Ma'monieh is the fifth largest community in the governorate and is located 7km north east of Madaba city with a current population of 6,380 which is projected to grow to 9,650 in 2035 resulting in a wastewater flow of 792m<sup>3</sup>/day and BOD load of 627 kg/d. The estimated length of the sewer system including the house connections is 29.7km using 3 m network/person. The estimated network cost is (4.2+1.7) 5.9 million JD and WWTP costs are 1.2 million JD.

### **Faisaliah**

Faisaliah is the sixth largest community in the governorate and is located 8km north -west of Madaba city with a current population of 6,101 which is projected to grow to 9,232 in 2035 resulting in a wastewater flow of 772m<sup>3</sup>/day and BOD load of 627 kg/d. The estimated length of the sewer system including the house connections is 28km using 3 m network /person. The estimated network cost is (3.9+1.6) 5.5 million JD and WWTP costs are 1.2 million JD.

Figure 7-4 shows the proposed system with additional wastewater needs for years 2015, 2025, and 2035.

## Investment Cost and Priorities

Table 7-4 below shows the estimated investment cost for Madaba governorate.

**Table 7-4: Estimated investment cost for Madaba governorate**

Service System	Item	Investment Cost (Million JD)		
		2012-2015	2016-2025	2026-2035
Madaba	Madaba system extension(trunk, collection sewer, house connection)	-	30.2	13.3
	Replacement of existing pipes	1.8		
Madaba	Madaba WWTP stage I,II	-	1.25	1.9
Milah	New WWTP	-	-	1.1
Milah	collection system	-	-	6.5
Deeban	New WWTP	-	-	1.1
Deeban	collection system	-	-	6.5
Maieen	New WWTP	-	1.3	-
Maieen	collection system	-	6.0	-
Ma'mounieh	New WWTP	-	1.2	-
Ma'mounieh	collection system	-	5.9	-
Fisalieh	New WWTP	-	1.2	-
Fisalieh	collection system	-	5.5	-
Madaba	Annual program for collection sewers and house connection expansion (1000 people/yr @ 303JD/capita)	0.3yearly (2010-2035)		
Capital Costs		1.8	52.65	30.3
Yearly Expansion programs		0.41 Million JD/year		

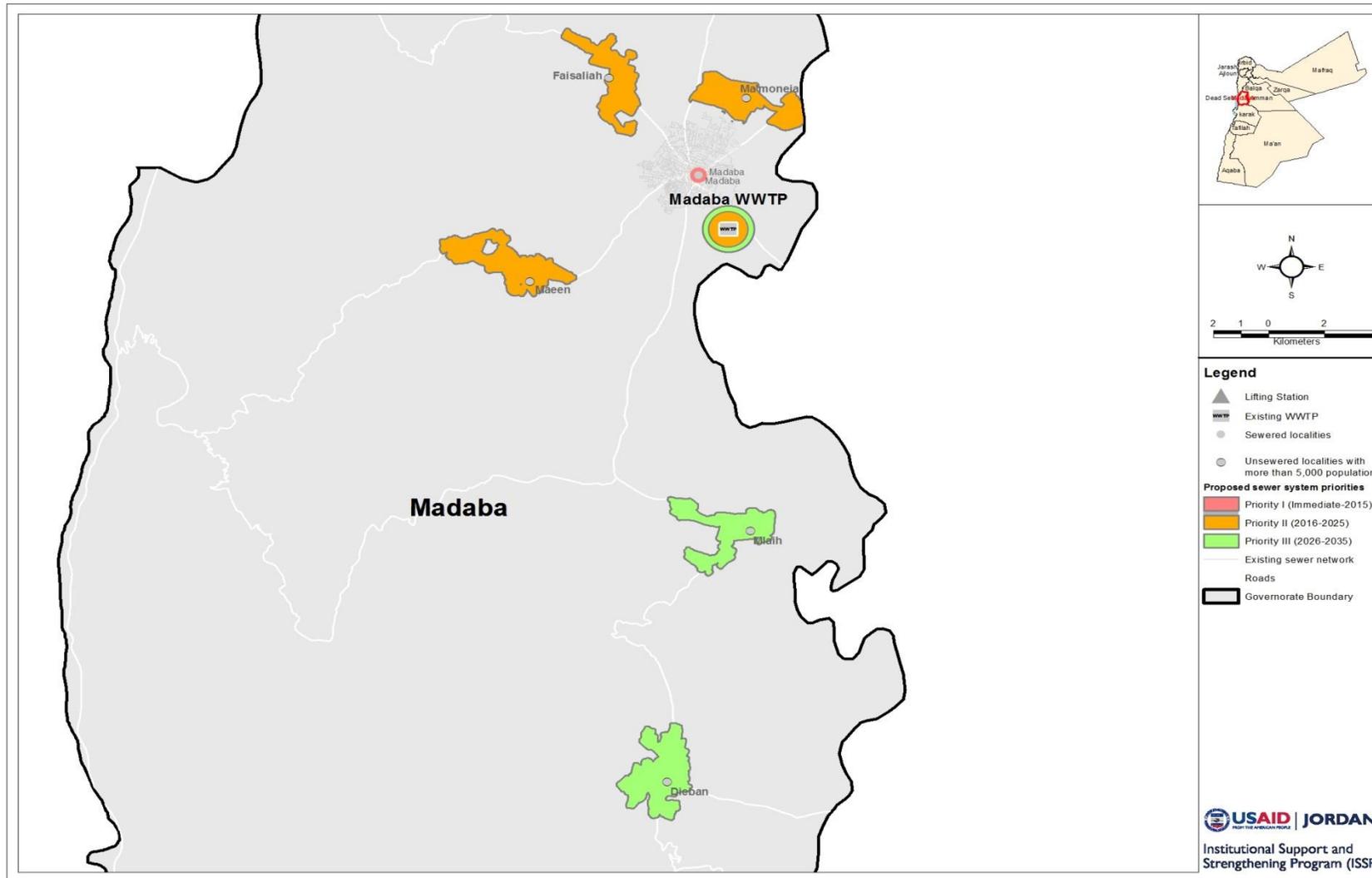


Figure 7-4: Madaba Governorate Investment Priorities

# 8 ZARQA

## Summary of Wastewater Assessment

Zarqa Governorate has current population of 951,800 (2012) which is projected to grow to 1,497,119 in 2035, an increase of 57.3% over the next 23 years. The population is distributed over 57 localities of which there are 7 with a population greater than 5,000 (Total population of 911,158 which is 95% of the total governorate population). The remaining 50 localities have population less than 5,000 (Total population of 40,642 which is 5% of the total governorate population). Currently, 11 localities are served by wastewater collection system while the remaining 46 are served by septic pits.

Within the sewer localities collectively only 685,296 people are connected to the sewer system which represents 72% of the total governorate population. The existing collection systems are supported by three existing pumping stations (West Zarqa, East Zarqa and Hitteen). All collected wastewater at West Zarqa and East Zarqa pumping stations is delivered to As Samra WWTP.

Based on the projected population of 1,267,000 by year 2025 and 1,497,119 by 2035, the following wastewater systems and treatment needs are estimated:

	Immediate (to 2015)	Year 2025	Year 2035
Needs	<ol style="list-style-type: none"> <li>1. Replacement of the 1400 mm diameter force main from WZPS to As Samra WWTP with 19.4 km length.</li> <li>2. Replacement of sewers pipes 200, 300, and 400mm dia. in WZPS system</li> <li>3. Replacement of 3.5 km of sewers pipes 200, 300, and 400mm in EZPS system</li> </ol>	<ol style="list-style-type: none"> <li>1. Additional wastewater collection and treatment systems for 103,804 people</li> <li>2. Septage wastewater treatment for 346,356 people</li> </ol>	<ol style="list-style-type: none"> <li>1. Additional wastewater collection and treatment systems for 202,216 people</li> <li>2. Septage wastewater treatment for 254,666 people</li> <li>3. Further expansion for As Samra WWTP beyond 2025</li> </ol>
Estimated Costs	<ol style="list-style-type: none"> <li>1. 32.2 million JD</li> <li>2. 1.2 million JD</li> <li>3. 0.94 million JD</li> </ol>	<ol style="list-style-type: none"> <li>1. 53 million JD</li> <li>2. 36.2 million JD</li> </ol>	<ol style="list-style-type: none"> <li>1. 73.02 million JD</li> <li>2. 26.64 million JD</li> <li>3. 63.0 million JD</li> </ol>

Details of the analysis of the existing situation with respect to wastewater collection and treatment and needed improvements for the future (up to 2035) with associated investment costs are presented in the following sections.

Cost to cover network expansion, for year 2015, and 2025, and 2035 are estimated. Following Table gives a summary of the estimated costs.

Priority	2012-2015	2016-2025	2026-2035
<b>Capital Costs</b>	<b>34.34</b>	<b>89.2</b>	<b>162.66</b>
<b>Yearly Expansion programs 3.1 Million JD/year (2015-2035)</b>			

## Introduction

Zarqa governorate is located in the Eastern of Amman. Zarqa is Jordan's industrial center, located in the Zarqa River basin, is home to over 50% of Jordanian factories. With a total current population of 951,800, Zarqa Governorate has the third largest population in Jordan after Amman and Irbid, whilst the city of Zarqa has the second largest population after Amman. This population is estimated to grow to 1,497,119 in 2035.

Zarqa governorate has 57 localities distributed over 6 districts:

- Zarqa
- Russeifa
- Al- Hashemiyah
- Al-Dhuleil
- Birein
- Azraq

Figure 8-1 shows districts and localities for Zarqa governorate

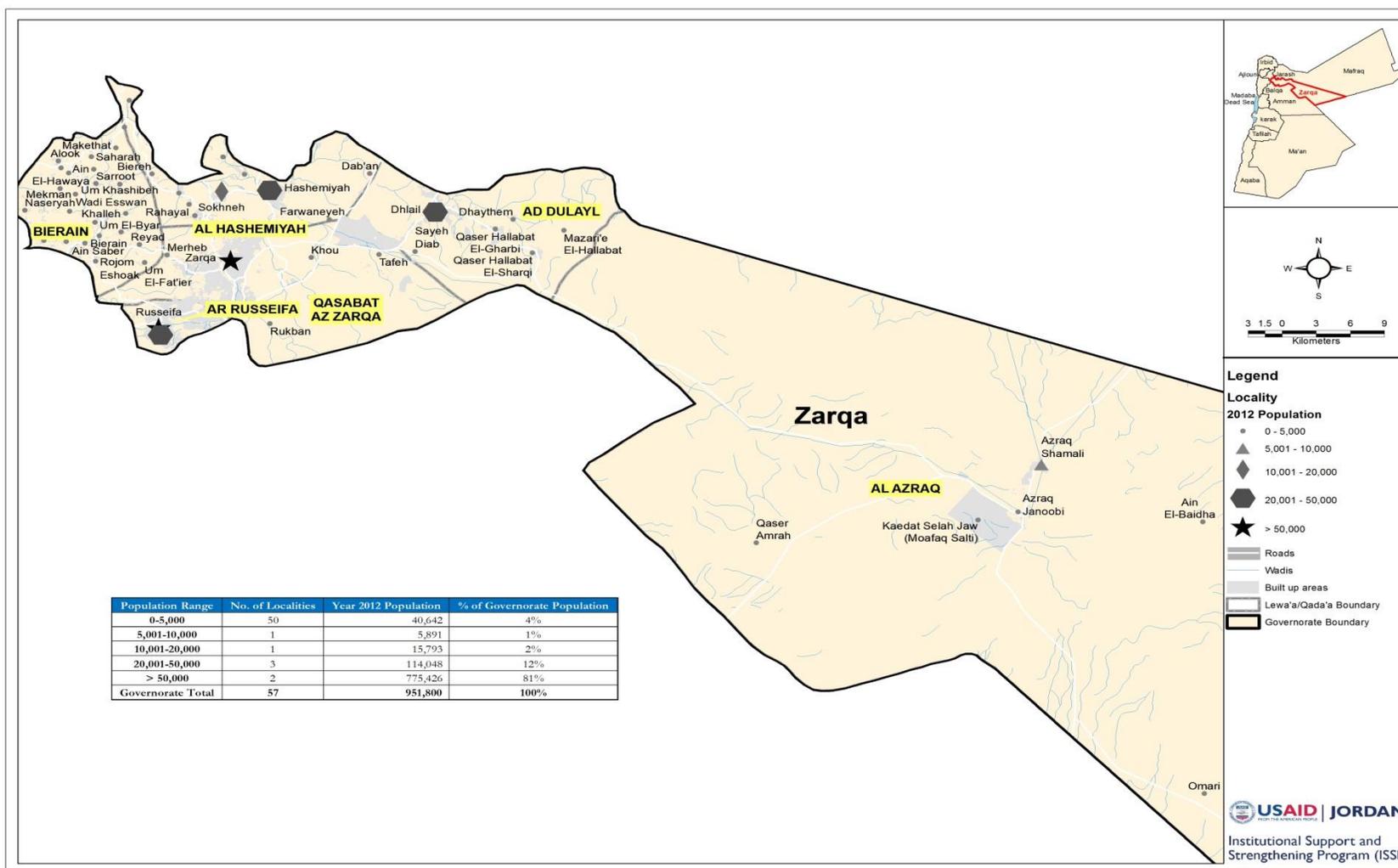


Figure 8-1: Districts and localities in Zarqa governorate

## **Wastewater Service Areas:**

The total length of the main trunk sewers with diameters equal to or above 300 mm is approximately 128 km. The secondary collection system is a dense network of 200 mm diameter sewers covering most of the populated areas of Zarqa, Russeifa and al-Hashemiyah with a total length of approximately 2005km serving 102,000,000 subscribers. Most of the sewers are constructed from concrete, and a small remainder is of ductile iron and vitrified clay.

The sewer systems in the governorate are served through two Pumps Stations supplying As Samra WWTP. The collection system is split into two systems draining to West Zarqa and East Zarqa pumping stations. The following is a brief description of the two collection systems:

### **West Zarqa – Russeifa System**

The areas served by this system include Russeifa and west Zarqa. In addition to the flows of the service area the network also receives wastewater flows from Tariq, Marka and parts of Shafa Badran, Jbaila and Nasser in northeast Amman. This system forms about 70% of the collection systems of the study area. Flow collected by this system drains to West Zarqa Pumping Station (WZPS) from where it is pumped to As Samra WWTP. Trunk sewers in the Russeifa/West Zarqa system are predominantly 300 to 1000 mm in diameter.

Wastewater collected from the lower elevations in Hitteen Camp and nearby areas is lifted by Hitteen Camp pump station to the nearby sewage collection system.

### **East Zarqa – al-Hashemiyah System**

This system serves East Zarqa and al-Hashemiyah, resulting in a sub-system that accounts for about 30% of the collection system in the study area. Flows collected from the area are conveyed by gravity to the East Zarqa Pumping Station (EZPS) and pumped to As Samra WWTP. Trunk sewers in the subsystem are predominantly 300mm to 800 mm in diameter.

## **Pumping Stations and Pumping Mains**

Zarqa sewerage system includes two main pump stations: WZPS and EZPS that deliver wastewater to As Samra WWTP and a small lifting station, Hitteen Camp Pumping Station (HCPS) that serves a small section of the camp and delivers to the Russeifa collection network. WZPS and EZPS are currently operated and maintained by the Samra Plant Operation & Maintenance Co. Ltd., and Hitteen Camp pumping station is operated by WAJ/Russeifa operations department.

### **West Zarqa Pumping Station:**

Wastewater collected from Russeifa, west Zarqa and the northern parts of Amman that drain downstream of Ain Gazal Transfer Plant (AGTP) is directed to WZPS, which delivers to As Samra WWTP through a 1200 mm pumping main. The 1200 mm pumping main is the downstream end of the siphon that originally was the main wastewater conveyor (siphon) pipeline from AGTP to As Samra treatment plant. After the commissioning of the 1500 mm AGTP - As Samra conveyor, the 1200 mm pipeline is now utilized by WZPS although the siphon is considered as an emergency conveyor for AGTP – As Samra WWTP. In the past when the 1200 mm siphon was used by AGTP, WZPS was operating at a discharge pressure of approximately 110 meters. According to the pump station daily and hourly logs, the average daily and hourly flows during 2009 were approximately 52,700 m<sup>3</sup>/d and 2,220 m<sup>3</sup>/hr respectively.

The pumping station was commissioned in 1985 and was refurbished in 2009 by installation of new pumps and associated electrical works. The capacity of the refurbished pumping station is 72,000 m<sup>3</sup>/ d. The emergency pond often acts as an additional wet well as the pumping capacity during peak flow hours is insufficient to pump the incoming flows. This creates operational difficulties and odor nuisance.

### **East Zarqa Pumping Station:**

Wastewater collected from East Zarqa and al-Hashemiyah is collected at the EZPS, which discharges to As Samra WWTP through one of two 500 mm diameter, 7.2 km long pressure mains under a head of approximately 74 meters. The pump station includes five pumps (4 duty + 1 standby) each rated to pump a flow of 420 m<sup>3</sup>/hr at 88 meters head. However currently at normal operating conditions only one or two pumps are operated. According to the pump station daily and hourly logs, the average daily and hourly flows during 2009 were

about 12,000 m<sup>3</sup>/d, and 860 m<sup>3</sup>/hr, respectively. It is noted that the pumping station is not working at full load. The pumping station was commissioned in 1988 and was refurbished in 2006 with installation of a new screen and an additional 500 mm diameter pumping main. The capacity of the pumping station is 40,320 m<sup>3</sup>/ d operating at 82 m head.

The pumping station is designed according to the normal growth of the service area; Nevertheless, There are new developments in King Abdallah bin Abdel Azziz city which tentatively will be served through the pumping station. Considerations shall be allocated to study increasing the pumping station capacity when the city is populated.

Recently in 2014, WAJ started a project of expansion and upgrade of East and West Zarqa Pumping station based on a design submitted through MCC project.

#### **Hitteen Camp Pumping Station:**

Wastewater collected from the lower elevations in Hitteen Camp and nearby areas is collected and lifted by the pump station to the nearby sewage collection system. The pump station is in a bad operational condition mainly attributed to an inefficient screen, where it is not holding the relatively high quantities of screenings, especially rags, that are clogging the pumps. Also, the station is lacking general equipment maintenance. There is a lack of records about the pump station details to give accurate information. Zarqa O&M temas recommended study of converting the system to a gravity system to overcome operational difficulties associated with the station location. This can be done by installing a trunk line of about 1.5 Km with an estimated diameter of 200mm. Overall cost estimate is around 1.5 million JD.

#### **As Samra WWTP:**

As Samra Wastewater Treatment Plant (WWTP) is the largest wastewater treatment facility in Jordan. The plant was built to replace the old and overloaded As Samra Wastewater Stabilization Ponds (WSP).

With a peak flow of 840,000 cubic meters each day, the facility treats an average flow of 267,000 cubic meters of wastewater on a daily basis, serving a population of about 2.2 million living in the Greater Amman and Zarqa areas. As Samra WWTP consists of a primary settling tank, eight aeration tanks and eight secondary settling tanks, four anaerobic sludge digesters, biogas and hydro-powered generators, and an odor control system. The aeration

tanks, secondary settling tanks and anaerobic sludge digesters tanks are all pre stressed with DYWIDAG Strand Tendons. The WWTP receives 80% of its electricity needs through a combination of hydraulic turbines and gas turbines powered by digestion biogas. The remaining 20% comes from the national grid.

An expansion of the facility began in 2012 and is expected to be completed by 2016. It will increase the plant's average treatment capacity to 365,000 cubic meters each day. It is being implemented along with the Wastewater Network Project of the Jordan Ministry of Water and Irrigation (MWI).

It is expected that this expansion will cover the treatment needs till year 2025, therefore it is envisioned that the plant will need further expansion for the horizon of year 2035, after taking into consideration the projected population for year 2035 for Amman, Zarqa, and Marfaq governorates from which the sewer flows to the plant. The cost for this expansion is estimated to be 63 MJOD.

Figure 8-2 shows existing wastewater systems in Zarqa governorate.

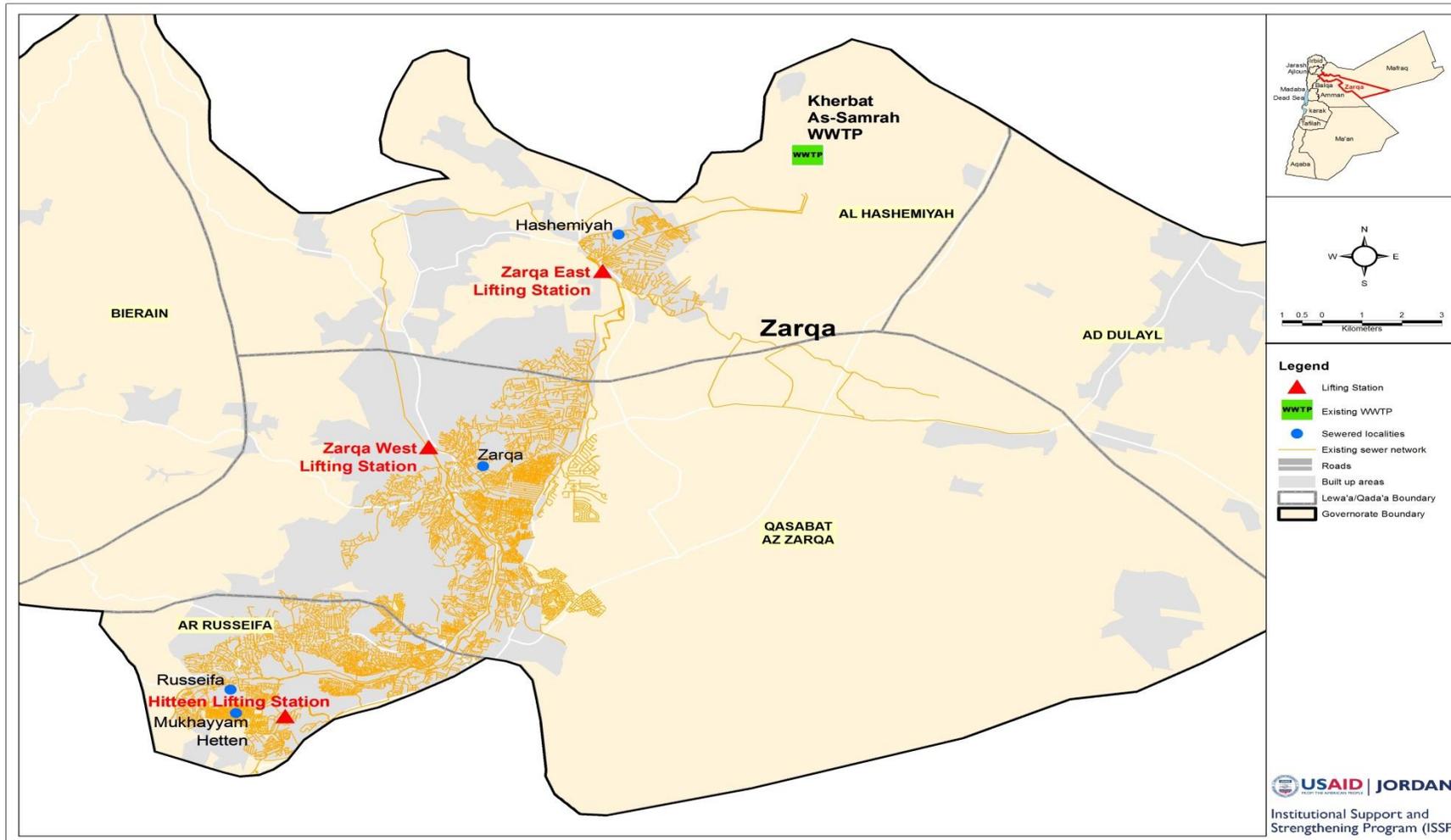


Figure 8-2: Existing wastewater systems in Zarqa governorate

## Unsewered Areas:

Areas that are not covered with sewer systems are served through septic pits that are likely not sealed. The population that is not covered with sewer systems is approximately 266,504, or 28% of the total population. Approximately 66,626 people (25.5% of the unsewered areas) are located within west Zarqa PS and East Zarqa PS systems. The remaining population is distributed in small localities all over the governorate. The 2 largest localities which have population greater than 5,000, Sukhneh and Dhuleil, contain 11.5% of the governorate population. Azraq locality with its both sides (north and south) is another locality which is envisaged for future wastewater service considering the vulnerability of Azraq ground water basin. It has 8,000 residents constituting about 1% of the governorate population. Other localities will continue to use septic pits as there is no history of water pollution or any health problems. Below (Table 8-1) is the list of the unsewered districts and their current population:

**Table 8-1: Unsewered Districts within Zarqa governorate with more than 5,000 population**

District	Current unsewered Population (2012)	% of Governorate Population
Sukhneh	50,125	5%
Dhuleil	60,030	6%
Azraq	8079	1%

Figure 8-3 shows the proposed wastewater systems in Zarqa governorate.

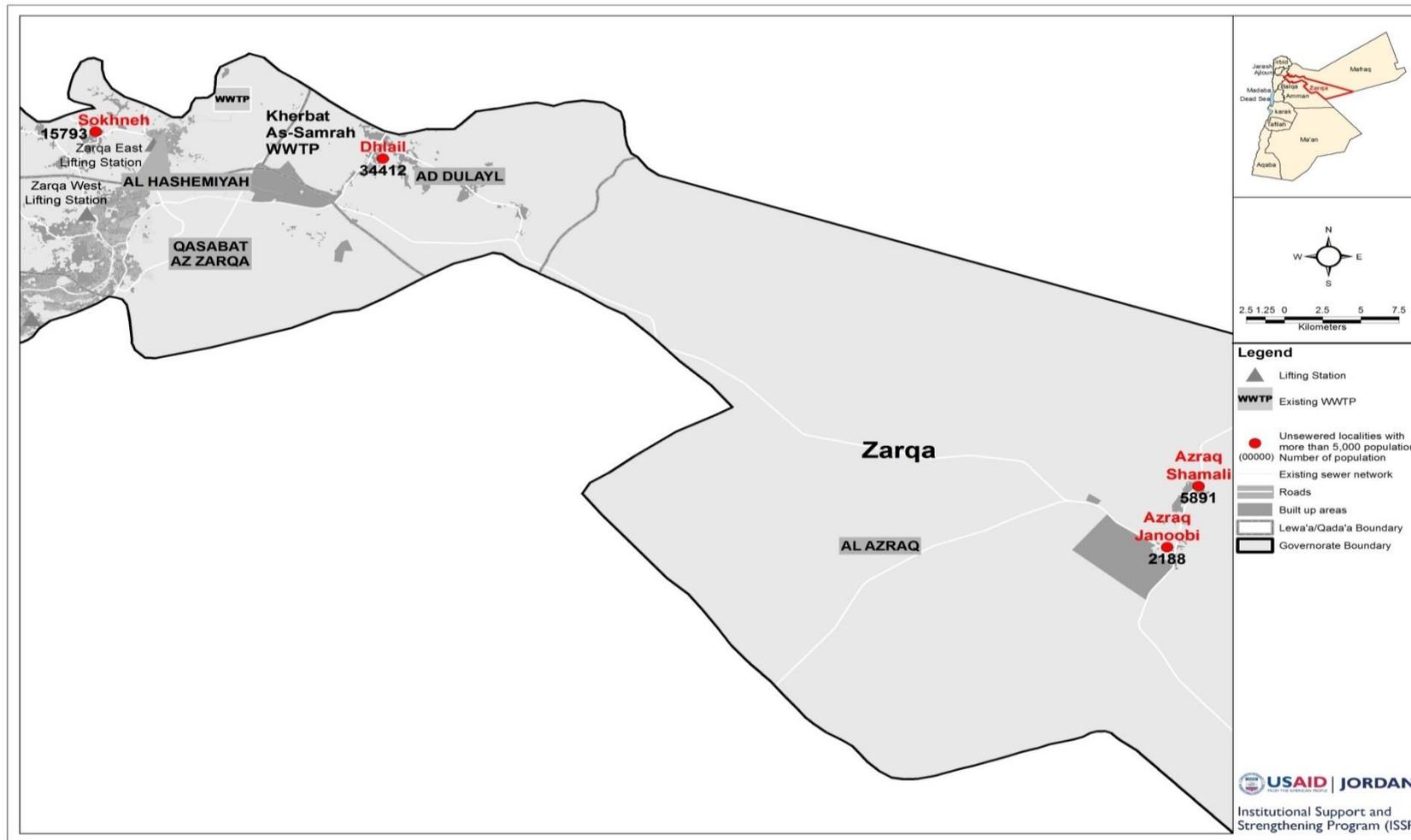


Figure 8-3: proposed wastewater systems for Zarqa governorate

## Projected Wastewater Loads

Table 8-2 below shows the population projections for both the currently served population and those in unsewered areas. The population projections are based on the MCC project data.

**Table 8-2 Population Projections for serve and unsewered area in Zarqa**

Service System	WWTP	Status	Served Population (2012)	% of total Gov. Population	Projected Population		
					2015	2025	2035
West Zarqa PS System	West Zarqa PS	Existing	479,707	50.4%	512,423	638,530	795,673
East Zarqa PS System	East Zarqa PS System	Existing	205,589	21.6%	219,610	273,656	341,003
Unsewered within West Zarqa PS Service area	West Zarqa PS	Proposed	46,638	4.9%	49,819	62,080	77,357
Unsewered within East Zarqa PS Service area	East Zarqa PS System	Proposed	19,988	2.1%	21,351	26,605	33,154
Sukhneh PS System	-	Proposed	-	5.3%	53,544	66,721	83,141
Dhuleil System	-	Proposed	-	6.3%	64,124	79,905	99,570
Azraq		Proposed	-	1%	8,579	10,478	12,798
Unsewered Localities below 5,000 population	-	-	-	16.1%	164,008	204,371	254,666

The above population figures were used to develop the wastewater flows and biological loads projections shown in Table 8-3.

**Table 8-3: Projected Wastewater flow and BOD Loads**

Service System	2015	2020	2025	2030	2035
<b>Projected Wastewater Flow (m<sup>3</sup>/d)</b>					
West Zarqa PS System	40,994	45,623	51,082	55,557	63,654
East Zarqa PS System	17,569	19,553	21,892	23,810	27,280
Unsewered within West Zarqa PS Service area	3,985	4,436	4,966	5,401	6,189
Unsewered within East Zarqa PS Service area	1,708	1,901	2,128	2,315	2,652
Sukhneh PS System	4,283	5,142	5,337	5,958	6,651
Dhuleil System	5,130	6,158	6,392	7,136	7,965
Azraq system	686	758	838	926	1,024
Unsewered Localities below 5,000 population	13,120	15,750	16,349	18,251	20,373
<b>Projected Wastewater load (BOD Kg/d)</b>					
West Zarqa PS System	33,307	37,068	41,504	45,140	51,719
East Zarqa PS System	14,275	15,887	17,788	19,346	22,165
Unsewered within West Zarqa PS Service area	3,238	3,604	4,035	4,389	5,028
Unsewered within East Zarqa PS Service area	1,388	1,545	1,729	1,881	2,155
Sukhneh PS System	3,480	4,178	4,337	4,841	5,404
Dhuleil System	4,168	5,004	5,194	5,798	6,472
Azraq system	558	616	681	753	832
Unsewered Localities below 5,000 population	10,661	12,798	13,284	14,829	16,554

## Identification of Wastewater Service Needs Through 2035

### West Zarqa PS System

The priority here is to rehabilitate the wastewater System. Based on the WIP report and MCC recent master plans studies the following are the major proposed improvements and rehabilitation requirements for the West Zarqa System:

-The pressure main from WZPS to As Samra WWTP requires to be upgraded in year 2025. The MCC study had proposed to add a 700 mm diameter pipeline in parallel to the existing pressure main (the old 1200 mm diameter siphon) to bring the total required equivalent diameter to 1400 mm. However, it is thought that installing a new 1400 mm diameter pipeline from WZPS to As Samra WWTP will be a better solution as this will free the existing 1200 mm diameter to be used as an emergency conveyance system from AGTP to As Samra by re-activating the old siphon system. The cost of installing 19.4 km of 1400 mm diameter pipeline from WZPS to As Samra WWTP would be approximately 32.2 million JD, using the unit costs established by MWH (2010).

In addition to these major improvements, 5.2 km of sewers pipes were identified to have problems and needed to be replaced as mentioned in MWH (2010); these pipes are 200 & 300mm in diameter.

Also, according to the discussions with the wastewater director in Zarqa, solving urgent network problems is required as priority 1 by installing 3200 m of network of diamters between 300mm and 400mm in Zarqa city, and 3300 m of network of diamters between 200mm, 300mm, and 400 mm in Rusaifah, with total approximate cost of 1.05 million JD.

According to the WZPS daily and hourly logs, the average daily and hourly flows during 2009 were about 52,700 m<sup>3</sup>/d, and 2,220 m<sup>3</sup>/hr respectively. The capacity of the refurbished pumping station is 72,000 m<sup>3</sup>/d. A new upgrade is needed in the near future for the most important component in the Zarqa wastewater system.

The current service coverage within the system is 85% with approximately 46,638 population not served within the West Zarqa PS service area. In the MCC project, they listed all the unsewered Neighborhoods that Drain to WZPS service area: Hai Umm Bayadhah, Hai al-

Dweik, Hai al-Falah, Hai al-Rasheed al-Shamali, (these Neighborhoods are over 5,000 in population).

### **East Zarqa PS System**

Based on the WIP and MCC recent master plans studies, the following are the major proposed improvements and rehabilitation requirements for EastZarqa System:

- The pressure main of the EZPS will require upgrading in year 2025, where a third 700 mm diameter pipeline will be required with a length of 6,473 m. The cost of this pipeline was estimated by MWH Feasibility Study (2010) to be 5.2 million JD.
- For this system the priority is to rehabilitate the wastewater System. 3.5 km of sewers pipes were identified to have problems and needed to be replaced as mentioned in MWH (2010), all of these pipes are 200mm in diammmter.

The current service coverage within the system is 88% with a population of about 19,988 not served within the East Zarqa PS service area. Inthe MCC report, it is mentioned that (Hai al-Batrawi) is the neighborhood with the most unsewered population in that service area.

### **Sukhneh**

A numbers of new sewer systems was proposed by MCC report, one of which is the Sukhneh PS Zone System. Within Sukhneh area there are 15 communities, of which 5 have populations above 5,000: Sukhneh, Hai al-Bustan, Hai al-Hashemi, Hai al-Ameera Haya, and Hai Nassar. The proposed system (beside the sewer network) consists of the following:

- 1- A Trunk line from Ghareisa to Sukhneh PS.
- 2- A Pumping Main from Sukhneh PS to EZPS.
- 3- The Sukhneh Pumping Station

## **Dhuleil**

Dhuleil town has a population of approximately 34,000. One of the systems that was proposed in the MCC report was Dhuleil sewer system which consists of, in addition to the sewer network of:

- 1- A Trunk line from Dhuleil to Wadi Dhuleil PS
- 2- A Pumping Main from Wadi Dhuleil to As Samra WWTP
- 3- The Wadi Dhuleil Pump Station.

## **Azraq**

The population of Azraq north and Azraq south is approximately 8,000. The projected population of 10,487 in 2025 will result in a wastewater flow of 838 m<sup>3</sup>/day and a BOD load of 681 kg/d. The estimated length of the sewer system including the house connections, is estimated to be 31.5 km using 3 m network /person. The estimated cost is approximately (4.5+1.9) 6.4 million JD and WWTP costs are 1.1 MJOD. Serving Azraq locality is envisioned as priority 2 due to its underground water basin vulnerability considerations.

Table 8-4 below illustrates the estimated costs needed to implement the required wastewater service needs to accommodate projected loads of the current systems and to expand the wastewater service area to cover localities with more than 5,000 population.

## **As Samra WWTP**

The current ongoing expansion for As Samra WWTP is expected to cover the treatment needs till year 2025, therefore it is envisioned that the plant will need further expansion beyond 2025 to serve projected population for all area served by As Samra WWTP in Amman, Zarqa, and Mafraq (Duhliel, Khaldieh, and Mabroukeh) governorates serving 700,000 additional people with an estimated cost of 63million JD.

**Table 8-4: Cost Estimate for Wastewater Service Investment with Priorities for Zarqa**

Service System	Item	Investment Cost (Million JD)		
		Immediate (2013-2015)	2016-2025	2026-2035
West Zarqa PS System and As Samra WWTP	Replacement of the 1400 mm diameter force main from WZPS to As Samra WWTP with 19.4 km length.	32.2		
	Replacement of sewers pipes 200, 300, and 400mm	1.2		
	Further expansion for As Samra WWTP	-	-	63
	Construction of wastewater collection system and house connections for the unsewered areas in West Zarqa System			18.8
	Upgrade West Zarqa Pump station		1.0	
East Zarqa PS System	Replacement of the forcemain of the EZPS by 700 mm diameter pipeline (6.5km)		5.18	-
	Replacement of sewers pipes of 200, 300, and 400mm diameter	0.94		
	Construction of wastewater collection system and house connections in unsewered areas in the East Zarqa System		6.4	
Sukhneh	Construction of wastewater collection system and house connection		32.4	
	Pumping Main from Sukhneh PS to EZPS		0.73	
	Sukhneh Pumping Station		2.09	
Azraq	Collection system and house connections and WWTP		5.2	
Dhuleil	Construction of wastewater collection system and house connections			48.4
	Trunk Line from Dhuleil to Wadi Dhuleil PS			2.8
	Pumping Main from Wadi Dhuleil to As Samra WWTP			1.41
	Wadi Dhuleil Pump Station			1.61
Governorate Total				
Capital Costs		<b>34.34</b>	<b>53</b>	<b>136.02</b>
Yearly Expansion programs		3.1 Million JD/year (2015-2035)		

\*Most of the cost estimated by MWH Feasibility Study (2010)

Figure 8-4 shows proposed system priorities for years 2015, 2025, and 2035.

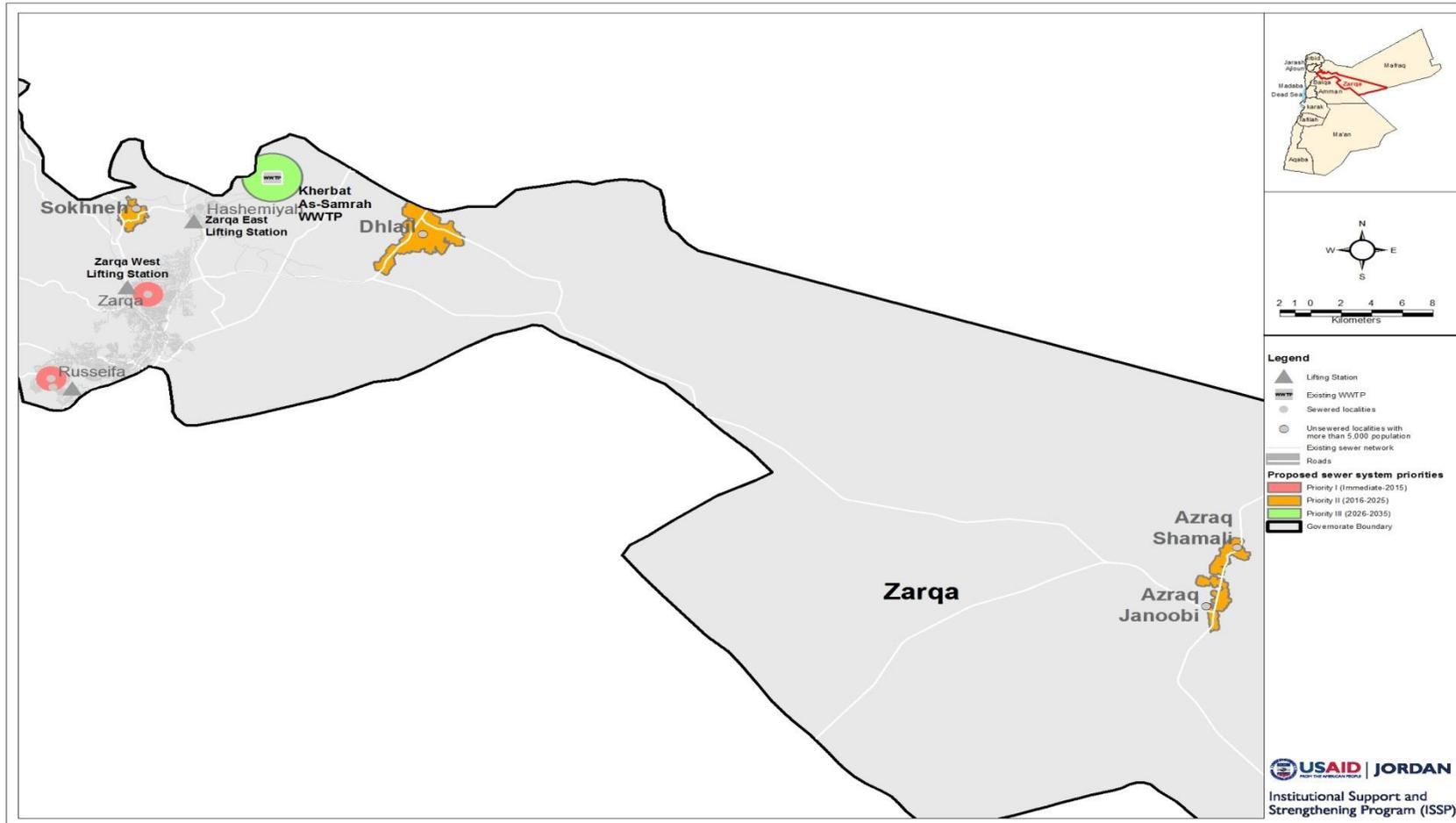


Figure 8-4: Proposed system priorities in Zarqa governorate

# 9 IRBID

## Summary of Wastewater Assessment

Irbid Governorate has a current population of 1,137,100 (2012) which is projected to grow to 1,764,207 in 2035, an increase of 55% over the next 23 years. The population is distributed over 137 localities of which 54 have a population greater than 5,000 with a combined population of 981,378 (86% of the governorate population). The remaining 83 localities have populations less than 5,000 with a total of 155,722 (14% of the governorate population). Currently, 12 localities are served by wastewater collection system while the remaining 125 are served by septic pits.

Within the sewered localities collectively only 594,404 people are connected to the sewer system which represents 52% of the total governorate population. There are 5 existing wastewater treatment plants with total design capacity to serve 751,274 people. Collectively, therefore, treatment capacity is available for an additional 176,870 people.

Based on the projected population of 1,519,625 by year 2025 and 1,764,207 by year 2035, the following wastewater systems and treatment needs are estimated:

	Immediate (to 2015)	Year 2025	Year 2035
Needs	1. Additional wastewater collection and treatment systems for 65,100 people to cover unsewered localities	1. Additional wastewater collection and treatment systems for 315,000 people 2. Septage wastewater treatment for 514,300 people (No. of unsewered population in 2025)	1. Additional (between 2025-2035) wastewater collection and treatment systems for 600,000 people 2. Septage wastewater treatment for 209,700 people (for localities of populations less than 5,000)
Estimated Costs	29 million JDs (including expansion of existing WWTPs)	1. 109 million JDs 2. 54 million JDs	1. 313 million JDs 2. 22 million JDs

Details of the analysis of the existing situation with respect to wastewater collection and treatment and needed improvements for the future (up to 2035) with associated investment costs are presented in the following sections.

## Introduction

Irbid governorate is located in the Northern part of Jordan. It has the second largest population in the country after Amman Governorate with a total population of 1,137,100 in 2012 with projected population in 2035 of 1,764,207. The governorate has the highest population density on the national level with approximately 725 persons/km<sup>2</sup>.

Most of the governorate is located on part of the Hawran plateau, which extends over northern Jordan, and south-west Syria. The governorate is bordered by Syria (the Golan Heights) from the north, Palestine from the west, Mafraq Governorate from the east, and Jerash, Ajlun and Balqa Governorates from the south.

The governorate has 120 localities distributed on 9 districts:

- Irbid Qasabah district
- Ramtha district
- Koorah district
- Bani Kenanah district
- Aghwar Shamaliyah district
- Bani Obeid district
- Mazar Shamali District
- Taybeh district
- Wastiyyah district

Figure 9-1 shows the governorate boundary, districts' boundaries and location of localities.

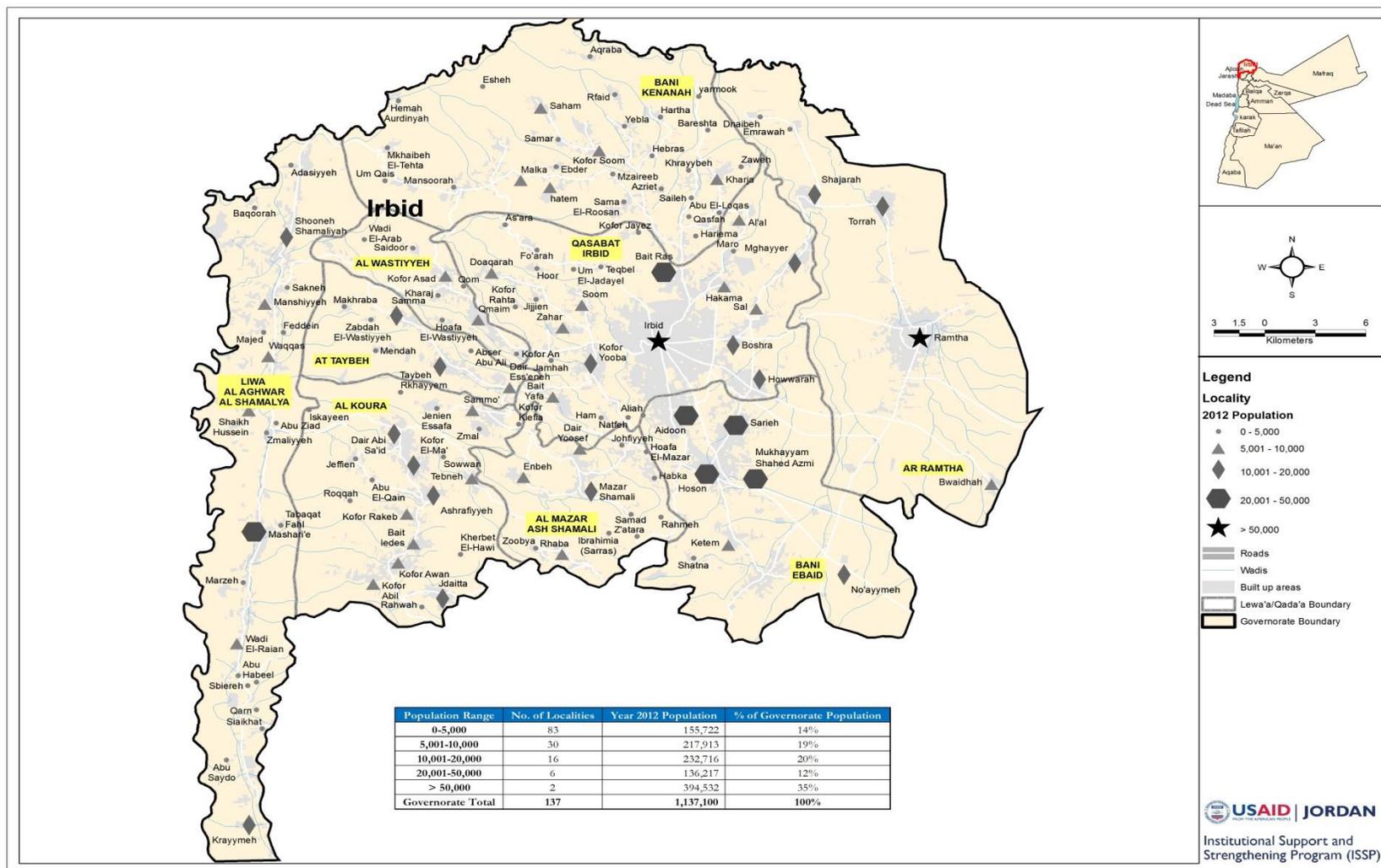


Figure 9-1: Irbid Governorate Districts and Localities

## Wastewater Service Area:

Irbid Qasabah contains about 41% of the governorate population (total of 460,090) and is the center of the governorate. The Qasabah contains two operating wastewater collection systems connected to two WWTPs; Central Irbid WWTP and Wadi Al Arab WWTP. The service area of the two WWTPs covers about 331,3661 people, representing a service coverage of approximately 72% the Qasabah area. The system has two lifting stations: Hakama Lifting station and Dahiet Al Hussein Lifting station.

A further wastewater collection and treatment system is located within Bani Obeid district. The system serves 4 localities: No'ayymeh, Ketem, Shatna, and Mukhayyam Al Shahed Azmi El-Mufti. There is no available information on the percentage of the population served within these localities. However, sewer networks cover fully built-up areas in all localities except in Hoson, where one third of the area is covered. The system is connected to Wadi Hassan WWTP and has two lifting stations: Wadi Hassan lifting station and Hoson Camp lifting station.

The other wastewater collection and treatment system is in place in Ramtha District and partially covers Ramtha Locality which has a population of 87,599 (65% of the District population). The system is connected to Ramtha WWTP with an estimated serviced population of 61,250 (5% of the governorate population).

WAJ recently finished construction of a new sewer system to cover West Irbid, Howwarah, Boshra, Sarih, Aidoon, and Hoson. Total population to be served through this system is 133,110 (12% of the governorate population). The new system will connect to Shallaleh WWTP which is still under construction and is planned to start operation before the end of 2013. The coverage in both Qasabah Irbid and Bani Obeid Districts will increase after operation of this system as it serves part of West Irbid and areas in the North and West part of Hoson locality.

List of served localities is shown in Table 9-1

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<sup>1</sup> Reuse for TWW for irrigation in the Northern Jordan Valley, Report of Feasibility Study Update, Dec 2011

**Table 9-1: Localities Served with Wastewater Collection and Treatment Systems**

District	Localities	Population 2012	System
Qasabah Irbid	Irbid	307,033	
Qasabah Irbid	Center (north)	-	Irbid Central
Qasabah Irbid	South and West	-	Wadi Al Arab
Qasabah Irbid	Irbid -North East Irbid	-	Shallaleh (New)
Qasabah Irbid	Soom	6,311	Wadi Al Arab
Qasabah Irbid	Doaqarah	5,779	Wadi Al Arab
Qasabah Irbid	Howwarah	15,622	Shallaleh (New)
Qasabah Irbid	Boshra	13,936	Shallaleh (New)
Qasabah Irbid	Sal	8,505	Shallaleh (New)
Qasabah Irbid	Natfeh	1,652	Shallaleh (New)
Bani Obeid	Hoson	25,093	Shallaleh (New)
Bani Obeid	Aidoon	22,767	Shallaleh (New)
Bani Obeid	Sarieh	23,532	Shallaleh (New)
Bani Obeid	No'aymeh	15,240	Wadi Hassan
Bani Obeid	Ketem	6,752	Wadi Hassan
Bani Obeid	Shatana	341	Wadi Hassan
Bani Obeid	Mukhayyam Al Shahed Azmi El-Mufti	20,353	Wadi Hassan
Ramtha	Ramtha	87,499	Ramtha
<b>Total Population Served</b>		<b>594,404</b>	
<b>Total Governorate Population</b>		<b>1,137,100</b>	
<b>% Served</b>		<b>52%</b>	

## Wastewater Treatment:

The Governorate has four operating WWTPs. 2 new WWTPs will be operational before the end of 2013, Shallaleh WWTP which will serve a population of about 133,110 in 2012; and Shauna Shamaliyah WWTP, which will be receiving wastewater loads from tankers.

**Central Irbid WWTP:** this plant is located in Al Bariha Neighborhood in the northern part of Irbid city, the WWTP has been operating for more than 22 years. The treatment process consists of trickling filters and activated sludge. The WWTP serves only part of Irbid City with a design capacity of 11,023m<sup>3</sup>/day. The plant operates at 78% of the hydraulic design capacity with current average wastewater hydraulic load of approximately 8,635m<sup>3</sup>/day. The design biological load is about 8,800kg/d while the plant receives an average BOD load of 8,279 kg/d. The plant currently serves an approximate population of about 117,914, whereas the design capacity is 135,668 people.

**Wadi Al Arab WWTP:** Located in Doaqarah, the WWTP was built in 1999 with an extended aeration treatment process. The WWTP serves areas southwest and east of Irbid. The plant hydraulic design capacity is 21,000m<sup>3</sup>/d and has a design biological load of 20,859kg/d. In 2012, the plant received an average flow of 10,681m<sup>3</sup>/d (51% of the design capacity) and biological load of 9,656kg/d (46% of the design BOD load). The plant currently serves approximate population of about 213,452 the design capacity is for 321,462 people.

**Wadi Hassan WWTP:** Located in An No'ayymeh locality and serving areas in Bani Obeid district, the WWTP has been operating since 2001. The treatment process consists of oxidation ditches. The plant hydraulic design capacity is 1,600m<sup>3</sup>/d and a design biological load of 1280kg/d. In 2012, the plant received an average flow of 1,238m<sup>3</sup>/d (77%% of the design capacity) and biological load of 1458kg/d (114% of the design BOD load) thus exceeding the design biological load. However, operational data from the plant in 2012 indicated that the effluent quality related to BOD is within the standards. The plant currently serves an approximate population of about 22,430 whereas the design capacity is for 19,692 people.

**Ramtha WWTP:** Located in Ramtha, the WWTP has been operating since 1988. The WWTP serves Ramtha. The plant was upgraded in 2005 from natural to mechanical treatment with an increase in design capacity to reach 5,400m<sup>3</sup>/day and a biological load of 5400kg/d (BOD design concentration of 1000mg/l). The plant currently receives an average hydraulic load of 4,050m<sup>3</sup>/d (75% of the design flow) and biological load of 3,596kg/d (67% of the design biological load). The plant currently serves an approximate population of about 61,250 whereas design capacity is for 113,846 people.

**Shallaleh WWTP:** The plant is located to the east of Irbid City and will be operated by end of 2013. The plant design capacity (Phase 1) is 13,700m<sup>3</sup>/d and has a design BOD load of 10,440 kg/d which capable of handling wastewater loads till 2015. Phase 2 includes expansion of the plant to a total design capacity of 22,330m<sup>3</sup>/d. The plant will serve localities in Qasabah Irbid and Bani Obeid. Served localities are also Hoson, Howwarah, Boshra, Sariéh, Aidoon, Sal, and west Irbid. Estimated total population to be served is about 133,1092 while designed for 160,606 people.

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<sup>2</sup> Reuse for TWW for irrigation in the Northern Jordan Valley, Report of Feasibility Study Update, Dec 2011

**Shauna Shamaliyah WWTP (Under Construction):** WAJ has recently finished construction of a septage wastewater treatment plant in Aghwar Shamaliyah District with a total capacity of 1000m<sup>3</sup>/d and a design BOD load of 1500kg/d. The plant is still in the commissioning stage and is expected to start operation by the end of 2013. The plant will serve localities in Aghwar Shamaliyah District.

Existing Wastewater systems in Irbid Governorate are shown in Figure 9-2.

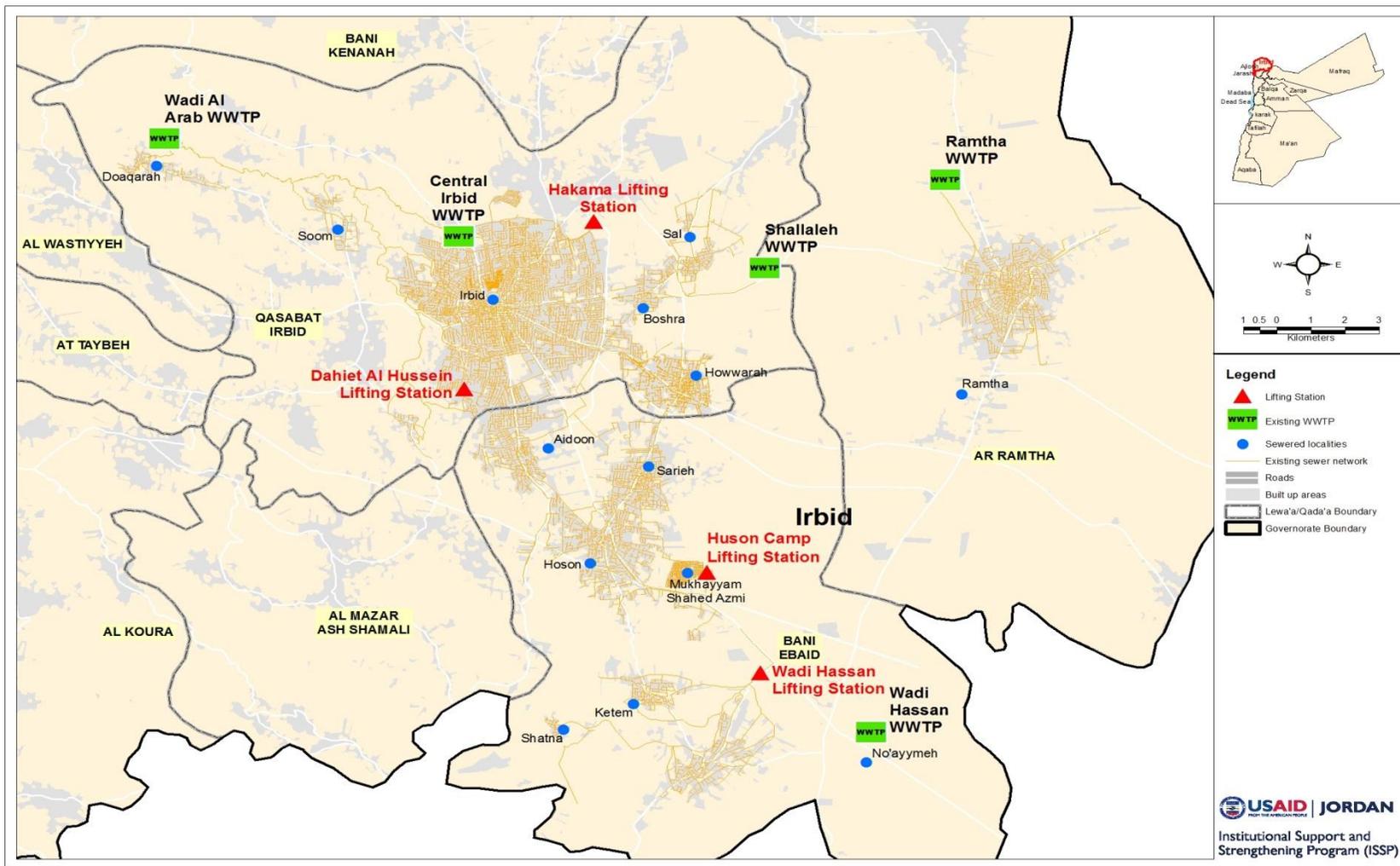


Figure 9-2: Existing Wastewater systems in Irbid governorate

## Unsewered Areas:

Wastewater networks serve only the central part and part of the eastern areas of the governorate with a total coverage of about 52%. Northern and western parts of the governorate do not have sewer systems and are discharging into septic pits. Below (Table 9-2) is a list of the unsewered districts and their current population:

**Table 9-2: Unsewered Districts within Irbid**

District	Current unsewered Population (2012)	% of Governorate Population
Koorah	111,530	10%
Aghwar Shamaliyah	104,370	9%
Bani Kenanah	93,580	8%
Mazar Shamali	54,100	5%
Taybeh	35,680	3%
Wastiyyah	29,450	3%

Additionally, some localities within the served districts are also not covered with sewer systems. Table 9-3 below shows the list of these districts. Total estimated number of unsewered population exceeds 554,600 in addition to the unsewered population within the service areas of sewer systems.

**Table 9-3: Unsewered localities with more than 5,000 population within served districts in Irbid**

District	Locality	Current unsewered Population (2012)	% of Governorate Population
Irbid	Bait Ras	22,078	1.9%
	Kofor Yooba	13,780	1.2%
	Mghayyer	10,625	0.9%
	Al'al	5,343	0.5%
	Hakama	9,093	0.8%
	Zahar	5,701	0.5%
	Bait Yafa	9,280	0.8%
Ramtha	Torra	18,183	1.6%
	Shajarah	14,115	1.2%
	Bwaidhah	6,677	0.6%

In this report, localities above 5,000 population are considered for sewer service needs assessment. Total population within these localities is about 400,878 (35% of the governorate population).

WAJ undertook two design studies for proposed systems in Irbid Governorate:

1. Sahel Horan: The proposed project will serve Torrah, Shajarah, Emrawah, and Dnaibeh localities within Ramtha District. Total population to be served is about 39,500; which is about 3.5% of the total governorate population. The wastewater will be collected from these localities and treated at Ramtha WWTP.

Another option to be considered is to divide Sahel Horan project into two phases, Torrah and Shajarah as phase 1, Emrawah and Dnaibeh as phase 2 depending on WAJ budget limitations.

2. Birgish: The proposed project will serve areas within Birqish Municipality that are located within Koorah District. Localities to be served are: Jdaitta, Kofor Awan, Kofor Abil, Bait Iedes, and Kofor Rakeb. Total population to be served under this study is about 43,000, which is about 4% of the total governorate population. The wastewater will be collected from these localities and treated at a new WWTP.

Unsewered Localities in Irbid Governorate are shown on Figure 9-3.

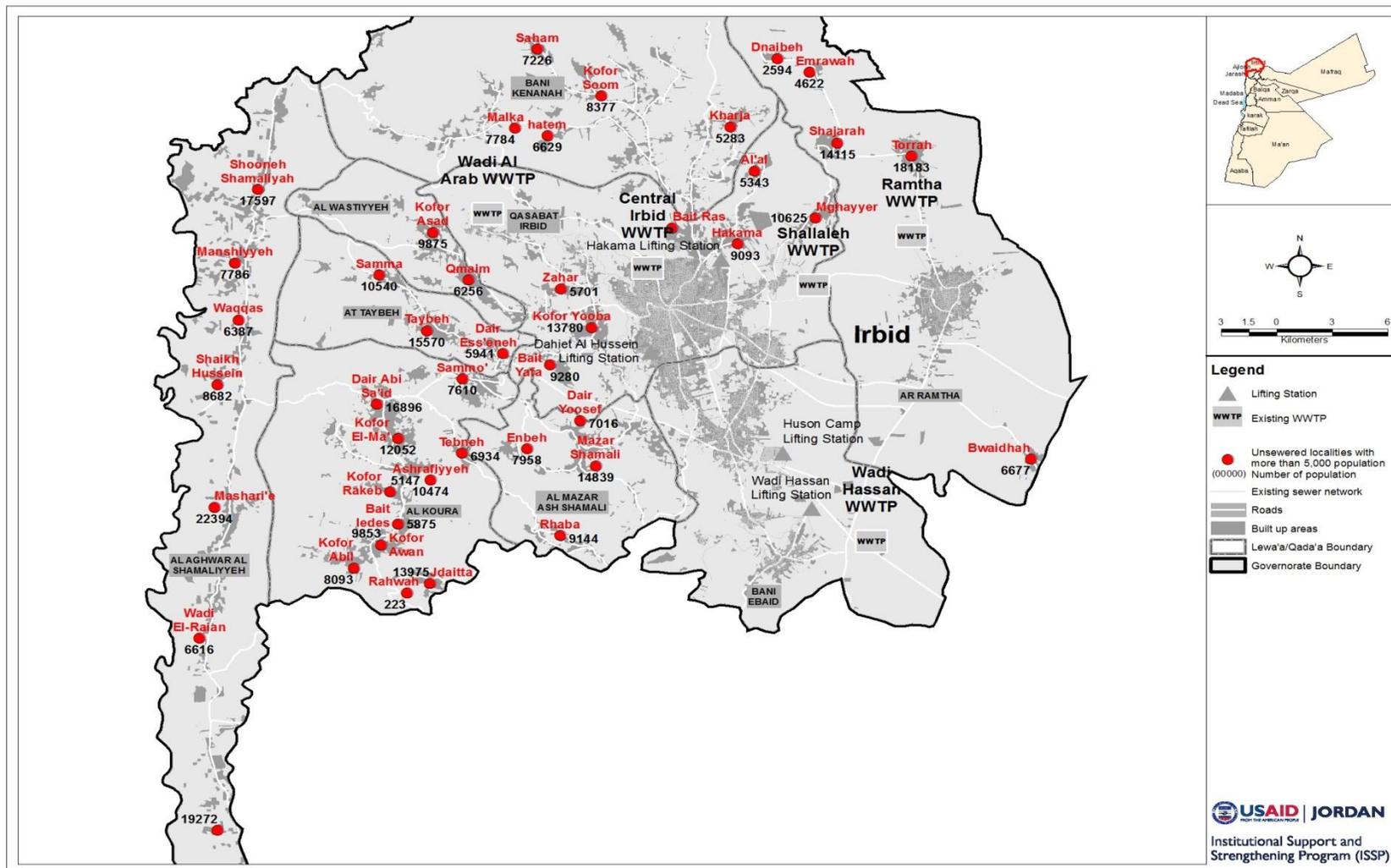


Figure 9-3: Unsewered Localities in Irbid Governorate

## Projected Wastewater Loads

Table 9-4 below shows the population projections for each of the currently served population and unsewered areas. The population projection figures used for Central Irbid, Wadi Al Arab, and Shallaleh are extracted from the Reuse for TWW for irrigation in the Northern Jordan Valley Project (Dec 2011).

**Table 9-4: Population Projections**

Service System	WWTP	Status	Estimated Served Population (2012)	% of total Gov. Population	Projected Population				
					2015	2020	2025	2030	2035
Irbid Central <sup>3</sup>	Irbid Central WWTP	Existing	117,914	10.4%	129,504	144,253	158,221	171,294	183,686
Wadi Al Arab <sup>3</sup>	Wadi Al Arab WWTP	Existing	213,452	18.8%	239,652	266,945	292,792	316,984	339,916
Wadi Hassan	Wadi Hassan WWTP	Existing	42,686	3.8%	45,054	49,297	53,940	59,020	64,578
Ramtha	Ramtha WWTP	Existing	87,499	7.7%	92,354	101,051	110,568	120,980	132,373
Shallaleh <sup>3</sup>	Shallaleh WWTP	Under Construction	133,109	11.7%	152,437	173,193	193,762	213,967	240,919
Unsewered Localities Above 5,000 population			400,878	35%	428,233	478,037	533,632	595,693	664,972
Unsewered Localities below 5,000 population	-	-	141,562	12.4%	127,460	143,186	170,745	211,760	259,764

The above population figures were used to develop the wastewater flows and biological loads projections shown in table 9-5.

<sup>3</sup> Estimate current served population and projected population are according to Reuse of TWW for Irrigation in the Northern Jordan Valley Project report (Dec 2011)

The Table shows:

- Irbid Central WWTP will reach the hydraulic design capacity and BOD load capacity around 2018
- Wadi Al Arab WWTP will reach the hydraulic design capacity in 2020
- Wadi Hassan WWTP currently receives BOL loads exceeding its design capacity. The plant will not be able to accommodate projected wastewater loads and will need to be expanded in 2015
- Ramtha WWTP will reach the hydraulic design capacity by 2015 and BOD capacity by 2025, the plant will need to be expanded in order to accommodate projected loads within its current service area
- Shallaleh WWTP: The phase 1 of the plant will be able to accommodate projected loads up to 2020. However, BOD projected loads indicate that the plant will reach the design capacity in 2015 which is the end of phase 1 as planned by WAJ. It is recommended that considerations for plant expansion to take place for 2015

**Table 9-5: Projected Wastewater flow and BOD Loads**

Service Area	2015	2020	2025	2030	2035
	Projected Wastewater Flow (m <sup>3</sup> /d)				
Irbid Central	10,360	11,540	12,658	13,704	14,695
Wadi Al Arab	19,172	21,356	23,423	25,359	27,193
Wadi Hassan	3,604	3,944	4,315	4,722	5,166
Ramtha	7,388	8,084	8,845	9,678	10,590
Shallaleh	12,195	13,855	15,501	17,117	19,274
Unsewered Localities Above 5,000 population	34,259	38,243	42,691	47,655	53,198
Unsewered Localities below 5,000 population	10,197	11,455	13,660	16,941	20,781
	Projected Wastewater load (BOD Kg/d)				
Irbid Central	8,418	9,376	10,284	11,134	11,940
Wadi Al Arab	15,577	17,351	19,031	20,604	22,095
Wadi Hassan	2,929	3,204	3,506	3,836	4,198
Ramtha	6,003	6,568	7,187	7,864	8,604
Shallaleh	9,908	11,258	12,595	13,908	15,660
Unsewered Localities Above 5,000 population	27,835	31,072	34,686	38,720	43,223
Unsewered Localities below 5,000 population	8,285	9,307	11,098	13,764	16,885

## **Identification of Wastewater Service Needs Through 2035**

### **Central Irbid WWTP System**

The priority in this service area is to expand the Central Irbid WWTP as it will reach the design capacity by 2018. Certain improvements and rehabilitation works will take place for this plant under the treated wastewater reuse project to produce treated wastewater that is suitable for reuse without any modification to the current design capacity. Improvements include demolishing the existing trickling filter and aeration tank and construction of new treatment facility including aeration tanks and clarifiers with addition of effluent filters and UV disinfection systems. Considerations shall also take place for a detailed study of the existing lifting stations and identification of any required upgrading. Estimate projected flow for the service area is 14,700m<sup>3</sup>/d by 2035). This means that additional capacity requirements will be 4,800m<sup>3</sup>/d

### **Wadi Al Arab WWTP System**

The priority is to expand the WWTP by 2020 in order to accommodate projected wastewater loads. Projected loads for 2035 (15 years span) is needed for the purposes of cost estimation and were based on the growth rate of wastewater loads in the last 5 years (2030-2035). Projected loading estimate for 2035 is about 27,200m<sup>3</sup>/d. This means that additional capacity requirements will be 6,000m<sup>3</sup>/d. The plant is also part of the reuse project which will implement certain improvements related to the treated wastewater quality and will not increase the plant capacity.

### **Wadi Hassan WWTP System**

The plant currently receives higher BOD loads than its design capacity and will reach the hydraulic design capacity in year 2015. The priority for investment shall be allocated for expansion of the system by 2015. Additional capacity needed to meet 2025 wastewater loads is 4,400m<sup>3</sup>/d.

### **Ramtha WWTP System**

The plant will need to be expanded by 2015 if it continues to receive loads from its current service area. A study that WAJ conducted recently to serve localities to the north of Ramtha City stated that the loads will be transferred to Ramtha WWTP. The study recommended expansion of the WWTP to meet the projected wastewater loads.

### **Shallaleh WWTP**

The WWTP will start operations by Oct 2013. An issue was raised by the plant design consultant about the capacity of the plant who claimed that the plant will be overloaded at the start of operations. In response to that, WAJ issued a technical memo stating that the plant will be able to accommodate loads until 2015 as designed for the first phase. The phase 2 of the plant will include increasing capacity of the plant up to 22,330m<sup>3</sup>/day and is planned to take place by 2015

### **Unsewered localities with population more than 5,000**

#### **Qasabah Irbid District**

This district is the biggest district in the governorate and is served by two operating wastewater systems (Central Irbid WWTP and Wadi Al Arab WWTP systems) and a further plant which will start operation this year (Shallaleh) thus giving a total coverage of about 71%. Seven Localities with more than 5,000 population are still not served: Bait Ras, Kofor Yooba, Mghayyer, Al'al, Hakama, Zahar and Bait Yafa.

Table 9-6 below shows the wastewater service needs for unsewered areas in Qasabah Irbid District

**Table 9-6: Wastewater Service Needs for unsewered localities in Qasabah Irbid District**

Locality	Current Population	Projected Population (2035)	Collection Wastewater System estimated Length (km)	Wastewater Treatment Needed (m <sup>3</sup> /d)	Estimated Biological Loads (BOD, KG/d)
Bait Ras	22,078	34,973	77	2,500	2,100
Kofor Yooba	13,780	21,829	59	1,900	1,420
Mghayyer	10,625	16,831	37	1,200	990
Al'al	5,343	8,464	23	750	550
Hakama	9,093	14,404	32	1,000	850
Zahar	5,701	9,031	25	800	590
Bait Yafa	9,280	14,700	40	1,300	960

#### **Ramtha District**

Ramtha City is the biggest locality in the district and is served through Ramtha WWTP. The remaining localities with more than 5,000 population are not served and were considered in a design project that was implemented last year; Sahel Horan Design Project. The proposed project will serve Torrah, Shajarah, Emrawah, and Dnaibeh localities in addition to serving the Northern Part of

Ramtha locality which is currently unsewered. This will increase the service coverage in the governorate by about 4%. The proposed system will include 8 lifting stations to transfer wastewater loads to existing Ramtha WWTP. It also system includes 125km of wastewater collection network and about 20km of pressure mains. The study recommended expansion of Ramtha WWTP in 2 phases; the first phase to serve projected wastewater loads up to 2025 and will take place in 2015. The second phase will serve projected population up to 2035 and to take place in 2025. The design flow in Phase 1 is 13,741m<sup>3</sup>/d and is 19,313m<sup>3</sup>/d in phase 2.

**Table 9-7: Wastewater Service Needs for unsewered localities in Qasabah Ramtha District**

Locality	Current Population	Projected Population (2035)	Collection Wastewater System estimated Length (km)	Wastewater Treatment Needed (m <sup>3</sup> /d)	Estimated Biological Loads (BOD, Kg/d)
Torrah	39,514	62,593	145	5,935 <sup>4</sup>	4,070
Shajara					
Emrawah					
Dnaibeh					
Bwaidhah	6,677	10,577	31.7	850	690

### **Koorah District**

This district is the third biggest district in the governorate with a total population of 111,530 which is about 10% of the total governorate population. The District contains 10 localities that have populations of more than 5,000.

Five localities are part of the Birgish design project that was implemented by WAJ in 2010; those are: Jdaitta, Kofor Awan, Kofor Abil, Bait Iedes, and Kofor Rakeb. Localities have a total current population of 42,950 (4% of the total governorate) and a projected population of 71,233 for 2035. The WAJ study proposed one WWTP to serve all five localities needing 7 lifting stations. The total length of the wastewater collection system is 163km in addition to pressure mains with a total length of 7.9km. The proposed WWTP capacity is 7,110m<sup>3</sup>/d.

<sup>4</sup> As estimated in the Sahel Horan Design Project

Three localities to the North of Birgish project were not considered as part of the study; Dair Abi Sa'id, Kofor El-Ma' and Ashrafiyyeh.

The total population of the three localities is about 39,400 (3.5% of the total governorate) and the projected population for 2035 is 62,447. Approximately 95% of the population is connected and can be served through one system. Estimated sewer length is about 118km. Three lifting stations are assumed to be required as systems are located in different catchments and are proposed to be served with one WWTP. The proposed treatment plant capacity is 5,000m<sup>3</sup>/day.

The remaining two localities are Tebneh and Sammo' which are located to the East and North part of the District. Two separate systems will be needed. Tebneh current population is 6,934 and is projected to be 10,984 in 2035. Total estimated length of the collection sewer is 20.8km and the treatment capacity needed is 880m<sup>3</sup>/d. In Sammo', the current population is 7,610 projected to become 12,055 in 2035. The estimated length of the collection sewer is 22.8km and the treatment capacity needed is 970m<sup>3</sup>/d. Table 9-8 below shows the wastewater service needs for unsewered areas in Koorah District

**Table 9-8: Wastewater Service Needs for unsewered localities in Koorah District**

Locality	Proposed System	Current Population	Projected Population (2035)	Collection Wastewater System estimated Length (km)	Wastewater Treatment Needed (m <sup>3</sup> /d)	Estimated Biological Loads (BOD, Kg/d)
Jdaitta	Birgish	42,950	68,025	163	7,110	4,420
Kofor Awan						
Kofor Abil						
Bait Iedes						
Kofor Rakeb	1 system	39,400	62,447	118	5,000	4,060
Dair Abi Sa'id						
Kofor El-Ma'						
Ashrafiyyeh	-	7,610	12,055	36	1000	860
Sammo'	-	6,934	10,984	33	970	790
Tebneh	-					

### **Bani Kenanah**

The district has 5 scattered localities with more than 5,000 population. Wastewater service needs to serve localities with more than 5,000 population are shown in Table 9-9.

**Table 9-9: Wastewater Service Needs for unsewered localities in Bani Kenanah District**

Locality	Current Population	Projected Population (2035)	Collection Wastewater System estimated Length (km)	Wastewater Treatment Needed (m <sup>3</sup> /d)	Estimated Biological Loads (BOD, Kg/d)
Kofor Soom	8,377	13,270	25	1070	865
Hatem	6,629	10,501	20	840	685
Saham	7,226	11,447	22	920	745
Malka	7,784	12,330	23	990	805
Kharja	5,283	8,369	16	679	545

### **Mazar Shamali**

The district has 4 localities with current population exceeding 5,000. Three such localities are adjacent and can be served through one WWTP; Mazar Shamali, Enbeh and Dair Yoosef. The remaining locality, Rabha will need a separate WWTP. Wastewater service needs to serve localities with more than 5,000 population are shown in Table 9-10.

**Table 9-10: Wastewater Service Needs for unsewered localities in Mazar Shamali District**

Locality	Current Population	Projected Population (2035)	Collection Wastewater System estimated Length (km)	Wastewater Treatment Needed (m <sup>3</sup> /d)	Estimated Biological Loads (BOD, Kg/d)
Mazar Shamali	29,813	47,226	142	3,780	3,070
Dair Yoosef					
Enbeh					
Rhaba	9,144	14,485	27	1,160	945

### **Aghwar Shamaliyah**

This district is located within the Jordan Valley area and has no sewer systems. The reason for this is that the Jordan Valley settlement areas are scattered along the main road from the Dead Sea to the north of the valley. It is not feasible to serve them given the high length of sewer systems needed

and the requirement for many lifting stations. The district has seven localities with population of more than 5,000. Localities are located in a narrow strip with a total length of 55km and an average width of 1km. Wastewater service needs to serve localities with more than 5,000 population are shown in Table 9-11.

**Table 9-11: Wastewater Service Needs for unsewered localities in Aghwar Shamaliyah District**

Locality	Current Population	Projected Population (2035)	Collection Wastewater System estimated Length (km)	Wastewater Treatment Needed (m <sup>3</sup> /d)	Estimated Biological Loads (BOD, Kg/d)
Shooneh Shamaliyah	17,597	27,875	53	2,230	1815
Mashari'e	22,394	35,474	67	2,840	2305
Krayymeh	19,272	30,528	58	2,445	1985
Wadi El-Raian	6,616	10,480	20	840	685
Shaikh Hussein	8,682	13,753	26	1,100	895
Manshiyyeh	7,786	12,334	23	990	805
Waqqas	6,387	10,117	19	810	660

### **Taybeh**

The district has three localities that have a population of more than 5,000; Taybeh, Samma and Dair Ess'eneh. Localities are distributed over a 8.5km long strip and can be served with one system connected to one WWTP. Table 9-12 below shows the wastewater service needs for the unsewered localities

**Table 9-12: Wastewater Service Needs for unsewered localities in Taybeh District**

Locality	Current Population	Projected Population (2035)	Collection Wastewater System estimated Length (km)	Wastewater Treatment Needed (m <sup>3</sup> /d)	Estimated Biological Loads (BOD, Kg/d)
Taybeh	32,051	50,771	96	4,065	3,300
Samma					
Dair Ess'eneh					

## Wastiyyah

The district has two localities with a current population of more than 5,000: Kofor Asad and Qmaim. Both can be served through one system as they are located close to each other with less than 2km distance. Table 9-13 below shows the wastewater service needs for the unsewered localities within Wastiyyah District.

**Table 9-13: Wastewater Service Needs for unsewered localities in Wastiyyah District**

Locality	Current Population	Projected Population (2035)	Collection Wastewater System estimated Length (km)	Wastewater Treatment Needed (m <sup>3</sup> /d)	Estimated Biological Loads (BOD, KG/d)
Kofor Asad	16,131	25,553	48	2,045	1,660
Qmaim					

Table 9-14 below illustrates the estimated costs needed to implement required wastewater service needs to accommodate projected loads of the current systems and to expand the wastewater service area to cover localities with more than 5,000 population.

**Table 9-14: Cost Estimate for Wastewater Service Needs in Irbid**

Service System	Item	Investment Cost (Million JD)				
		Immediate (2013-2015)	2020	2025	2030	2035
Central Irbid	Expansion of WWTP – Phase 1 (Immediate): additional capacity of 1,700m <sup>3</sup> /d (total needed capacity is 12,700m <sup>3</sup> /d) to serve loads up to 2025 Phase 2 (2025) additional capacity of 2,000m <sup>3</sup> /d (total needed capacity is 14,700m <sup>3</sup> /d) to serve loads up to 2035	1.9		2.2		
Wadi Al Arab	Expansion of WWTP – Phase 1 (Immediate): additional capacity of 4,400m <sup>3</sup> /d (total needed capacity is 25,400m <sup>3</sup> /d) to serve loads up to 2030 Phase 2 (2030): additional capacity of 4,600m <sup>3</sup> /d (total needed capacity is 30,100m <sup>3</sup> /d) to serve loads up to 2040		4.8		5.1	
Wadi Hassan	Expansion of WWTP – Phase1 (immediate): Total capacity	3.1		1.1		

Service System	Item	Investment Cost (Million JD)				
		Immediate (2013-2015)	2020	2025	2030	2035
	of 4,400m <sup>3</sup> /d to serve loads up to 2025 Phase2 (2025): Total capacity of 5,400m <sup>3</sup> /d to serve loads up to 2035					
Ramtha	Expansion of WWTP to serve projected loads and Sahel Horan Project loads – Phase 1 13,700m <sup>3</sup> /d up to 2025 and phase 2 19,313m <sup>3</sup> /d up to 2035	14.7 <sup>5</sup>		2.45		
Shallaleh	Phase 2 of WWTP expansion as planned	9.5				
	Annual Expansion program for wastewater collection and house connections expansion for the existing systems (Average yearly growth up to 2035) 1100 people/yr @ 303JD/capita	3.33 yearly (2015-2035)				
Unsewered localities in Qasabah Irbid District	Construction of wastewater collection system and house connections Phase 1 (2020): Bait Ras, Mghayyer, and Hakama Phase2(2030): Kofor Yooba, Al'al, Zahar and Bait Yafa		29.7		29.6	
	Treatment Costs needed Phase 1(2020): Bait Ras, Mghayyer, and Hakama Phase2(2030): Kofor Yooba, Al'al, Zahar and Bait Yafa		5.2		6	
Unsewered localities in Ramtha District	Construction of wastewater collection system and house connections Phase 1 (2020)– Sahel Horan (Treatment costs needs are included in Ramtha WWTP expansion) Phase 2 (2035)– Bwaidhah		30.65			6.4
	Construction of WWTP Phase 2 – Bwaidhah					1.1
Unsewered	Construction of wastewater		25.9		31	14

<sup>5</sup> Prices as estimated in WAJ Sahel Horan Design Project

Service System	Item	Investment Cost (Million JD)				
		Immediate (2013-2015)	2020	2025	2030	2035
localities in Koorah District	collection system and house connections Phase 1 (2020): Birgish Project <sup>6</sup> Phase2 (2025): Dair Abi Sa'id, Kofor El-Ma', and Ashrafiyyeh Phase3(2035): Sammo' and Tebneh					
	Construction of WWTP Phase 1 (2020): Birgish Project 6 Phase2 (2025): Dair Abi Sa'id, Kofor El-Ma', and Ashrafiyyeh Phase3(2035): Sammo' and Tebneh		6.9		5.5	2.6
Unsewered localities in Bani Kenanah District	Construction of wastewater collection system and house connections for 5 localities					34
	Construction of WWTPs (Total of 5)					4.8
Unsewered localities in Mazar Shamali District	Construction of wastewater collection system and house connections Phase 1 (2015): Mazar Shamali, Dair Yoosef, and Enbeh Phase2(2025): Rhaba				18.1	7.2
	Treatment Costs needed Phase 1(2015): Mazar Shamali, Dair Yoosef, and Enbeh Phase2(2025): Rhaba				4.2	1.3
Unsewered localities in Aghwar Shamaliyah District	Construction of wastewater collection system and house connections					85.2
	Wastewater Treatment Needs					12.9
Unsewered localities in Taybeh District	Construction of wastewater collection system and house connections				22.8	
	Constriction of WWTP				4.5	
Unsewered localities in Wastiyyah	Construction of wastewater collection system and house connections				14	

<sup>6</sup> Prices as estimated in WAJ Birgish Design Project

Service System	Item	Investment Cost (Million JD)				
		Immediate (2013-2015)	2020	2025	2030	2035
District						
	Constriction of WWTP				2.3	
<b>Governorate Total</b>						
	Capital Costs	29	103	6	143	170
	Yearly Expansion programs	3.33 yearly (2015-2035)				

Figure 9-4 below illustrates needed investment in wastewater collection and treatment through 2035

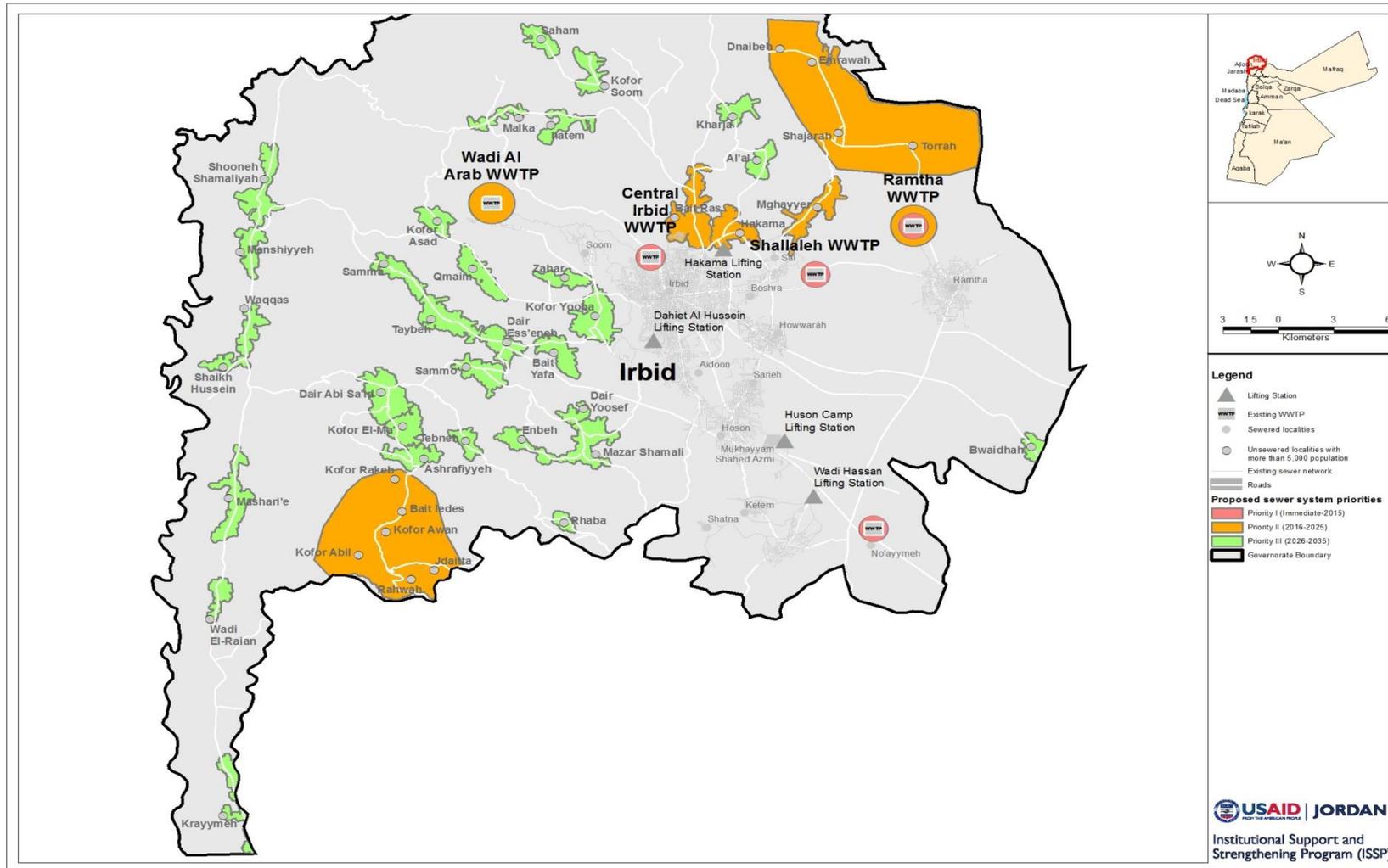


Figure 9-4: Irbid Governorate Investment Priorities

# 10 MAFRAQ

## Summary of Wastewater Assessment

Mafraq Governorate has a current population of 300,300 (2012) which is projected to grow to 485,343 by 2035 with an increase of 61.6% over the next 23 years. The population is distributed over 172 localities, of which 12 have a population greater than 5,000 (representing in total a population of 139,102, which is 46% of the governorate population). The remaining 160 localities have populations less than 5,000 totalling a population of 161,198, which is 54% of the total governorate population. Currently, one locality is served by a wastewater collection system while the remaining 171 are served by septic pits.

Within the sewerred localities collectively only 24,000 people are connected to the sewer system which represents 8% of the total governorate population. There is one existing wastewater treatment plant with a total design capacity serving 14,680 people. Records show that the maximum flow arriving at the WWTP exceeded the design capacity. There is on-going expansion of the WWTP (mechanical) to increase the capacity to serve 76,788 people.

Based on the projected population of 408,825 by year 2025 and 485,343 by year 2035, the following wastewater systems and treatment needs are estimated:

	Immediate (to 2015)	Year 2025	Year 2035
<b>Needs</b>	<ol style="list-style-type: none"> <li>No treatment needs – Immediate needs are covered by existing WAJ projects.</li> <li>Network improvements (repair of collector and house connections)</li> <li>Construction of 7Km of 600mm pipes to the WWTP</li> </ol>	<ol style="list-style-type: none"> <li>Additional wastewater collection and treatment systems for 111,308 people</li> <li>Septage wastewater treatment for 48,857 people</li> </ol>	<ol style="list-style-type: none"> <li>Additional wastewater collection and treatment systems for 101,989 people</li> <li>Septage wastewater treatment for 49,205 people</li> </ol>
<b>Estimated Costs</b>	<ol style="list-style-type: none"> <li>0 million JD</li> <li>0.17 million JD</li> <li>4.5 million JD</li> </ol>	<ol style="list-style-type: none"> <li>44.4 million JD</li> <li>4.3 million JD</li> </ol>	<ol style="list-style-type: none"> <li>44.85 million JD</li> <li>4.3 million JD</li> </ol>

Details of the analysis of the existing situation with respect to wastewater collection and treatment and needed improvements for the future (up to 2035) with associated investment costs are presented in the following sections.

## **Introduction**

Mafraq governorate is located in the North- East part of Jordan with a total population of 300,300 in 2012 representing 4.5% of Jordan's population. The projected population in 2035 is 485,825. Mafraq governorate covers the second largest area in the Kingdom, but has the second smallest population density (after Ma'an).

It is the only governorate in Jordan that has borders with three countries: Iraq to the east, Syria to the north, and Saudi Arabia to the south. It is bordered by Irbid and Jerash governorates to the west, and by Zarqa governorate to the south.

The governorate has 172 localities distributed on 4 districts:

- Mafraq Qasabah
- Badiyah Shamaliyah district
- Badiyah Sh.Gh. district
- Rwaished district

Figure 10-1 shows the governorate districts and localities

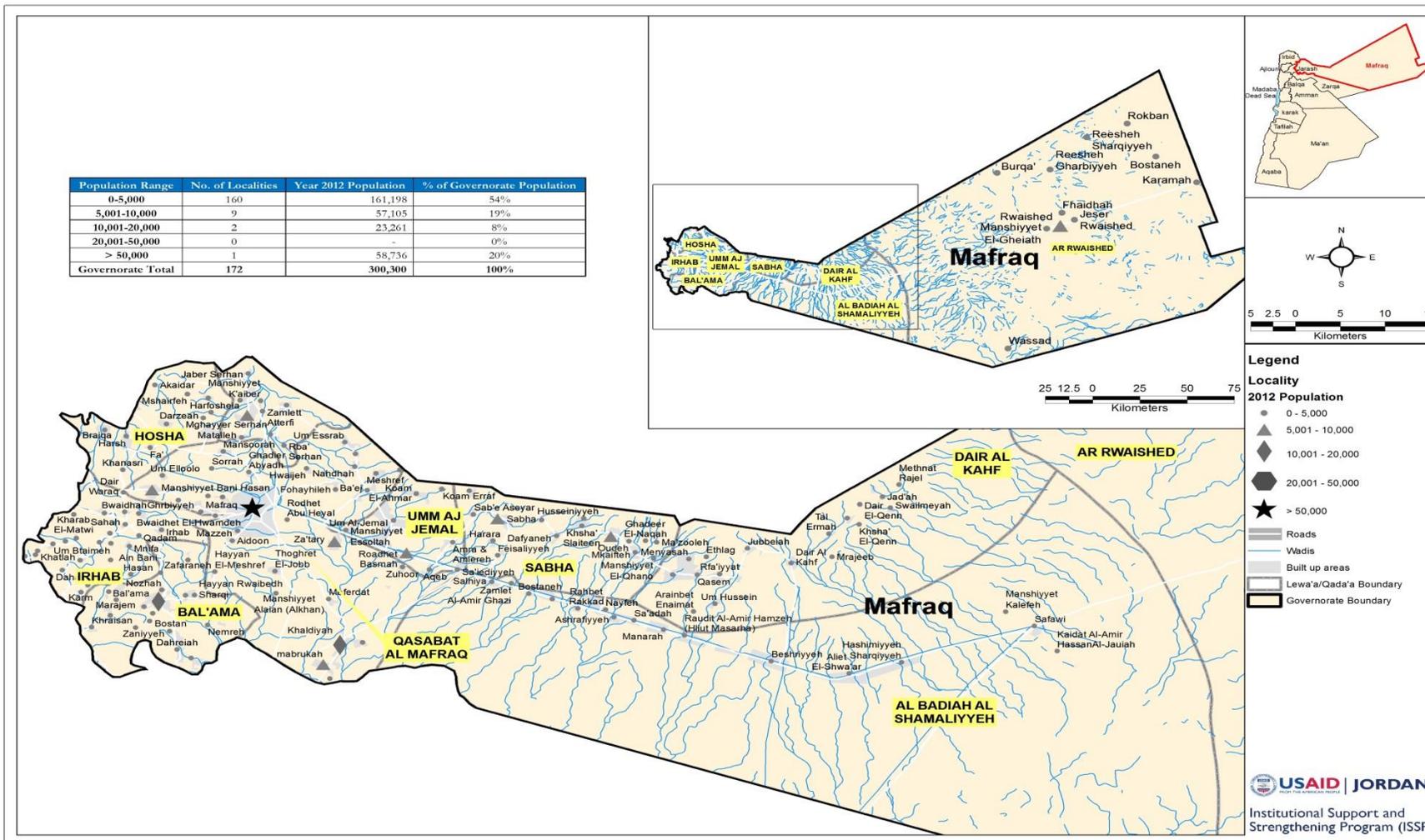


Figure 10-1: Mafrq Governorate Districts and Localities

## **Wastewater Service Area:**

The only wastewater system in Mafraq governorate is Mafraq city wastewater system.

Mafraq city contains about 20% of the governorate population (total of 58,736). The wastewater collection systems are connected to Mafraq WWTP through a 1000mm pipe line. The service area of Mafraq WWTP covers about 24,000 people. Mafraq wastewater system serves 25% of Mafraq city. The system serves the following neighborhoods: Al-Janoobi, Al-Hussain, and Al-Thobat, and has a total sewer network 91.82 km in length.

## **Wastewater Treatment:**

The Governorate has one operating WWTP:

### **Mafraq WWTP:**

Mafraq WWTP is a Waste Stabilization Ponds process. Mafraq WWTP design capacity is 1800 m<sup>3</sup>/day. and has a design biological load of 4,991 kg/d. Records show that the maximum flow arriving at the WWTP exceeded the design capacity. There is on-going expansion of the WWTP (mechanical) to increase the capacity to 6050 m<sup>3</sup>/day which will serve the unsewered area of Mafraq city and treat the wastewater flow that will come from Manshiyyet Bani Hasan proposed system by a new lift station.

Existing Wastewater system in Mafraq is shown in Figure 10-2.



Figure 10-2: Existing Wastewater system in Mafraq governorate

## Unsewered Areas:

The wastewater service system serves only parts of Mafraq city with a total coverage of about 8% of the governorate population. The other parts of the governorate do not have sewer systems and currently discharge to septic pits.

Table 10-1 below shows the list of unsewered localities with more than 5,000 population. The total estimated number of unsewered population (within Mafraq Governorate) exceeds 241,500 excluding the unsewered population within the service areas of existing sewer systems which amounts to approximately 44,040 people.

**Table 10-1: Unsewered localities with more than 5,000 population in Mafraq**

District	Locality	Current unsewered Population (2012)	% of Governorate Population
Mafraq Qasabah	Manshiyyet Bani Hasan	8,354	3%
Mafraq Qasabah	Bal'ama	10,551	3.51%
Badiyah Shamaliyah	Sabha	6,283	2.09%
	Roadhet Basmah	5,579	1.86%
	Um-Elgotain	5,349	1.78%
Badiyah Sh.Gh.	Za'tary	6,218	2.07%
	Mghayyer Serhan	7,385	2.46%
	Khaldiyah	12,710	4.23%
	Mabrookah	5,246	1.75%
Rwaished	Rwaished	5,179	1.72%

In this report, localities above 5,000 population are considered for sewer service needs assessment. Total population within these localities is about 64,500 (21% of the governorate population).

WAJ undertook a design study for proposed systems in Manshiyyet Bani Hasan. Total population to be served in Manshiyyet Bani Hasan is about 8,350, which is about 3% of the total governorate population. The wastewater will be collected and pumped to the Mafraq WWTP.

Figure 10-3 shows proposed wastewater systems for unsewered localities

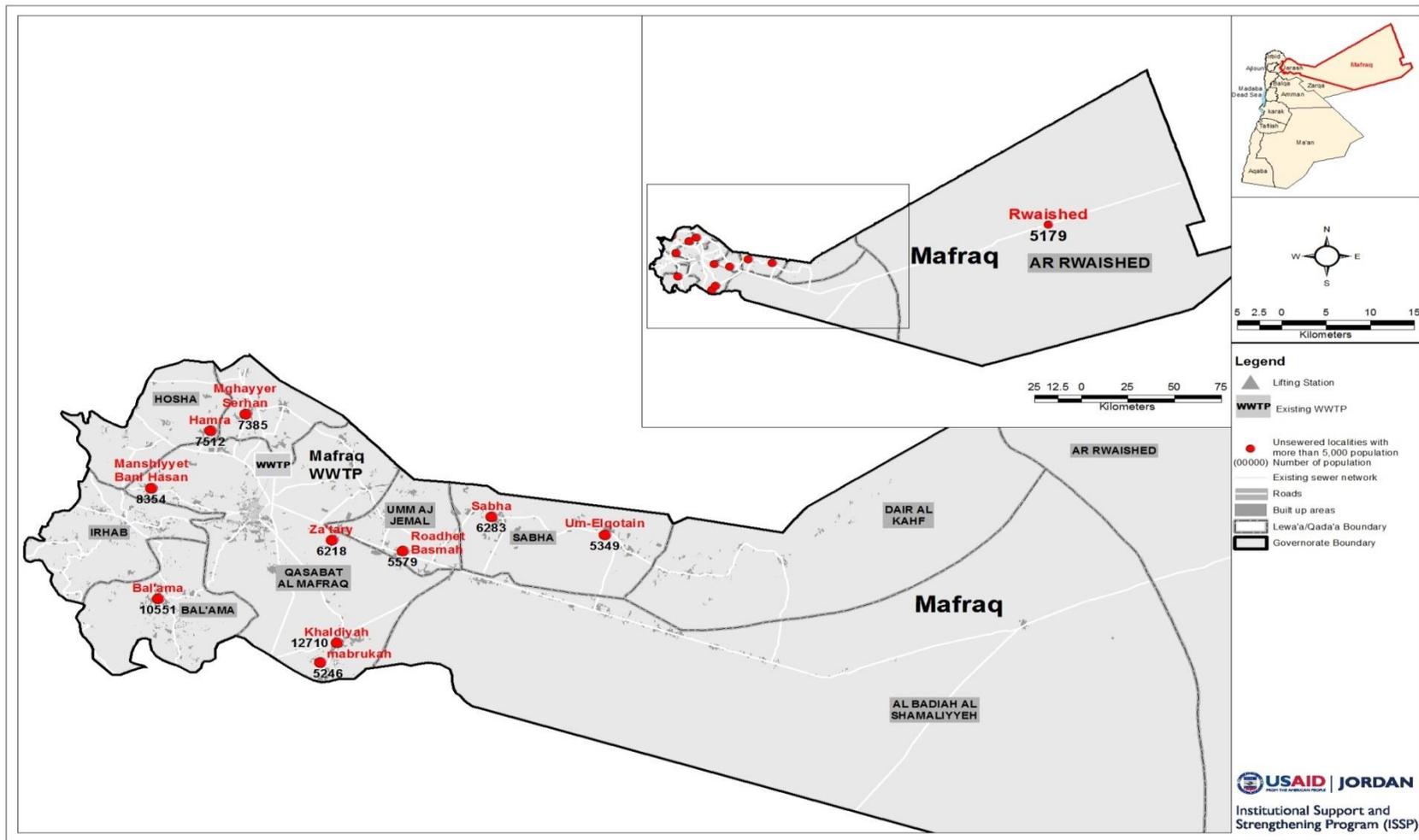


Figure 10-3: Proposed wastewater systems for unsewered localities in Mafraq governorate

## Projected Wastewater Loads

Table 10-2 below shows the population projections for each of the current served population and unsewered areas.

**Table 10-2: WWTP Status and Population Projections in Mafraq**

Service System	WWTP	Status	Estimated Served Population (2012)	% of total Gov. Population	Projected Population				
					2015	2020	2025	2030	2035
Mafraq	Mafraq WWTP	Existing	24,000	8%	25,561	28,390	31,534	35,025	38,902
Manshiyyet Bani Hasan	Manshiyyet Bani Hasan P.S.		8,354	3%	8,991	9,987	11,092	12,320	13,684
Unsewered Localities Above 5,000 population			108,556	36%	115,789	128,608	142,846	158,660	176,226
Unsewered Localities Below 5,000 population	-	-	161,710	54%	170,682	189,579	210,567	233,879	259,772

The above population figures were used to develop the wastewater flows and biological loadings projections shown in Table 10-3.

**Table 10-3: Projected Wastewater flow and BOD Loads in Mafraq**

Service Area	2015	2020	2025	2030	2035
<b>Projected Wastewater Flow (m<sup>3</sup>/d)</b>					
Mafraq	2,045	2,271	2,523	2,802	3,112
Manshiyyet Bani Hasan	719	799	887	986	1,095
Unsewered Localities above 5,000 population	9,263	10,289	11,428	12,693	14,098
Unsewered Localities below 5,000 population	13,655	15,166	16,845	18,710	20,782
<b>Projected Wastewater load (BOD Kg/d)</b>					
Mafraq	1,661	1,845	2,050	2,277	2,529
Manshiyyet Bani Hasan	584	649	721	801	889
Unsewered Localities above 5,000 population	7,526	8,360	9,285	10,313	11,455
Unsewered Localities below 5,000 population	11,094	12,323	13,687	15,202	16,885

## **Identification of Wastewater Service Needs Through 2035**

### **Mafrag WWTP System**

The Mafrag WWTP System serves only 25 % of Mafrag city, and the WWTP has reached its design capacity (1,800 m<sup>3</sup>/day). There is on-going expansion of the WWTP, with the new design capacity of (6,050 m<sup>3</sup>/day) to serve the unsewered area within Mafrag city and the flow from Manshiyyet Bani Hasan. The population of usewered neighborhoods near the system is approximately 44,040.

The main trunk line (1000mm) that collects all the flow of the Mafrag sewer system had flooded in the past. **Priority** in this system, therefore is to study and replace or rehabilitatethis main line especially if new expansions are constructed in the future.

### **Manshiyyet Bani Hasan P.S. System**

WAJ undertook a design study for systems in Manshiyyet Bani Hasan. It was proposed that the sewer flow in this system will be pumped to Mafrag WWTP. However, implementation was postponed because of lack of funding.

### **Bal'ama**

Mafrag City, Manshiyyet Bani Hasan, and Bal'ama are the three biggest localities in Mafrag district with a total population of 125,080 which is about 42% of the total governorate population. Bal'ama is located 25 km South-West of Mafrag City and is the only locality in the district beside Mafrag and Manshiyyet Bani Hasan with a population of more than 5,000.

### **Badiyah Shamaliyah District**

This district has the third largest population in the governorate with a total population of 70,970 which is about 24% of the total governorate population. The District contains three localities that have population of more than 5,000. These localities are: Sabha, Roadhet Basmah, and Um-Elqotain. The three localities could be served by one WWTP.

### **Badiah Sh.Gh. District**

This district has the second largest population in the governorate with a total population of 92,190 which is about 31% of the total governorate population. The district has four localities with populations of more than 5,000. These localities are: Za'tary, Mghayyer Serhan, Khaldiyah, and Mabrookah.

### **Rwaished District**

Rwaished district is the largest district in the governorate but has the smallest population of 12060 which is about 4 % of the total governorate population. The district has one locality with a population of more than 5,000 and that is Rwaished. Rwaished is located on the road to Iraq (78 km from Iraqi border) and has a population of 5,179.

Table 10-4 below shows the wastewater service needs for unsewered areas in Mafraq Governorate Districts.

**Table 10-4: Wastewater Service Needs for Unsewered Localities in Mafraq**

District	Locality	Current Population	Projected Population (2035)	Collection Wastewater System estimated Length (km)	Wastewater Treatment Needed (m <sup>3</sup> /d)	Estimated Biological Loads (BOD, Kg/d)
Mafraq Qasabah District	Bal'ama	10,551	17,502	32	1,400	1,136
Badiah Shamaliyah District	Sabha	6,283	10,422	19	834	676
	Roadhet Basmah	5,579	9,254	17	740	600
	Um-Elqotain	5,349	8,873	16	710	576
Badiah Sh.Gh.	Za'tary	6,218	10,314	19	825	669
	Mghayyer Serhan	7,385	12,250	22	980	795
	Khaldiyah	12,710	21,083	38	1,687	1,368
	Mabrookah	5,246	8,702	16	696	565
Rwaished	Rwaished	5,179	8,591	16	687	557

Table 10-5 below illustrates the estimated costs needed to implement required wastewater service needs to accommodate projected loads of the current systems and to expand the wastewater service area to cover localities with more than 5,000 population.

Figure 10-4 shows proposed system priorities for years 2015, 2025, and 2035.

**Table 10-5: Cost Estimate for Wastewater Service Needs in Mafraq**

Service System	Item	Investment Cost (Million JD)		
		Immediate (2013-2015)	2016-2025	2026-2035
Mafraq City	Replacement or rehabilitation of the main sewer pipe 1000mm (immediate). Construction of wastewater collection system and house connections	0.17	-	-
	Construction of 7Km of 600mm pipes to the WWTP	4.5		
	Construction of wastewater collection system and house connections for the rest of Mafraq city	-	16.6	10.0
Manshiyyet Bani Hasan	Construction of wastewater collection system and house connections including Pump Station	-	5.2	
Unsewered localities in Mafraq Qasabah District	Construction of wastewater collection system and house connections for Bal'ama	-	8.4	
Unsewered localities in Badiah Shamaliyah District	Construction of wastewater collection system and house connections: Phase 1:Sabha, Roadhet Basmah Phase 2:Um-Elqotain	-	-	10.4
	Construction of WWTP	-	-	5.0
Unsewered localities in Badiah Sh.Gh. District	Construction of wastewater collection system and house connections Phase 1:Khaldiyah, Mabrookah Phase 2:Mghayyer Serhan, Za'tary	-	14.2	13.3
	Construction of WWTPs (Total of 2)	-	-	2.3
Unsewered localities in Rwaished District	Construction of wastewater collection system and house connections for Rwaished	-	-	3.1
	Construction of WWTP	-	-	0.75
<b>Governorate Total</b>				
Capital Costs		4.67	44.4	44.85
Yearly Expansion programs		3.7 Million JD/year (2015-2035)		

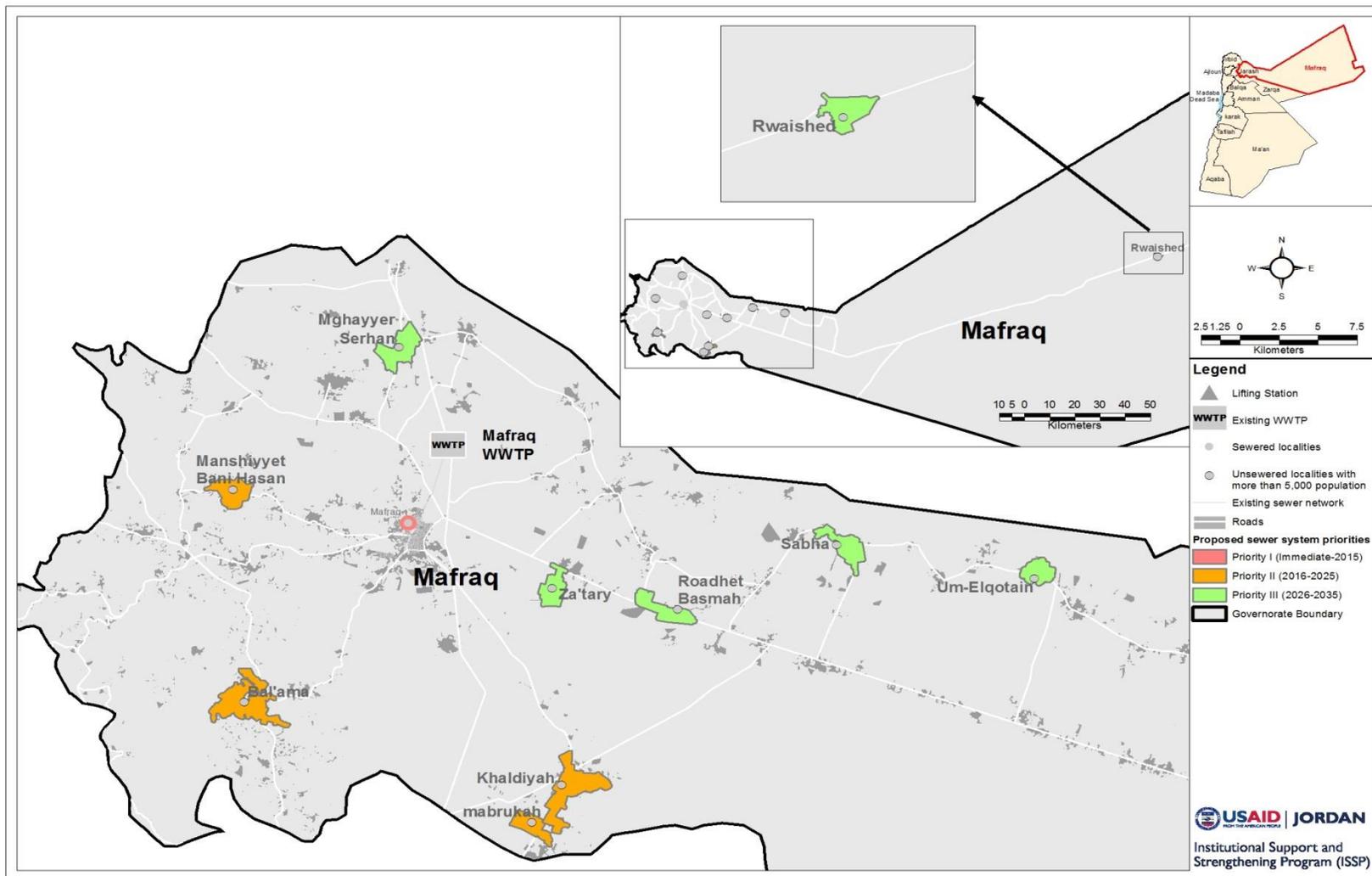


Figure 10-4: Proposed system priorities for Mafraq Governorate

# II JERASH

## Summary of Wastewater Assessment

Jerash governorate has a current population of 191,700 (2012) which is projected to grow to 336,976 in 2035, an increase of 76% over the next 23 years. The population is distributed over 55 localities out of which 10 have a population greater than 5,000. The remaining 45 localities have populations less than 5,000. Currently 7 localities are served by wastewater collection systems while the remaining 48 are served by septic pits.

Within the served localities collectively only 132,144 people are connected to the sewer system which represents 69% of the total governorate population. There are 2 existing wastewater treatment plants with a total design capacity to serve 166,250 people having thus available treatment capacity to serve an additional 34,106 people.

Based on the projected population of 276,267 by year 2025 and 336,976 by year 2035, the following wastewater systems and treatment needs are estimated:

	Immediate (to 2015)	Year 2025	Year 2035
Needs		<ol style="list-style-type: none"> <li>1. Additional wastewater collection and treatment systems for 36,893 people</li> <li>2. Septage wastewater treatment for 11,504 people</li> </ol>	<ol style="list-style-type: none"> <li>1. Additional wastewater collection and treatment systems for 91,916 people</li> <li>2. Septage wastewater treatment for 13,361 people</li> </ol>
Estimated Costs		<ol style="list-style-type: none"> <li>1. 15 million JD</li> <li>2. 1.0 million JD</li> </ol>	<ol style="list-style-type: none"> <li>1. 9.1 million JD</li> <li>2. 1.2 million JD</li> </ol>

Details of the analysis of existing situation with respect to wastewater collection and treatment and needed improvements for the future (up to 2035) with associated investment costs are presented in the following sections.

Table below shows estimated cost to cover the expansion of the WWTP and of the existing network for year 2015, and 2025, and 2035.

Governorate Total (MJOD)			
Priority	2012-2015	2016-2025	2026-2035
Capital Costs	-	16	10.3

## Introduction

Jerash governorate is located in the north part of Jordan, about 40 Km north of Amman, south of Irbid, to the west of Mafraq, and the east of Ajloun Governorate

Jarash has the smallest land area of the 12 Governorates in Jordan; the 410 km<sup>2</sup> land area of Jerash is less than 0.5% of Jordan's total land area of 88,778 km<sup>2</sup>. Jerash's population in 2012 of 191,700 is projected to grow to 336,976 by 2035. The governorate has a population density of approximately 468 person/km<sup>2</sup>.

Jerash governorate has 50 localities distributed throughout 3 districts:

- Jerash district
- Al-Mastabah district
- Burma district

Figure 11-1 shows the population distribution within localities and districts.

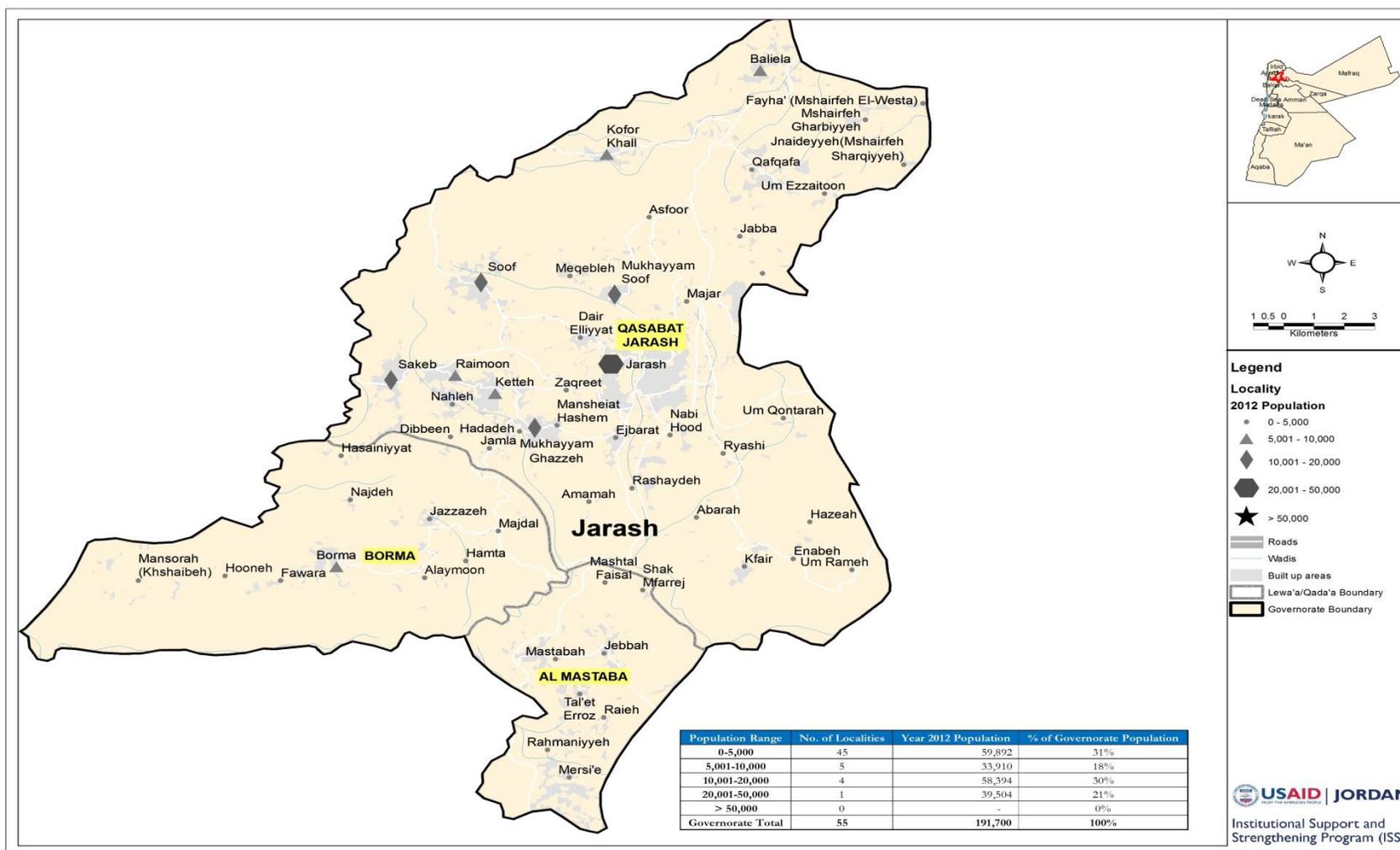


Figure 11-1: Jerash Governorate Districts and Localities

## **Wastewater Service Area:**

The existing sewer service areas cover 16 localities, (7 urban and 9 rural) with a total service coverage of about 69% of the governorate population. The sewer systems in the governorate are served through two WWTPs, namely the East WWTP and the West WWTP.

All seweried localities are located in the Jarash district which has a population of 132,144. About 67,494 are served through the sewer system connected to the East WWTP. There are two interceptors in the East system, designated as the 'Line A' interceptor and the 'Soof' interceptor. They run in parallel to and crisscross each other but do not inter-connect and have various diameters ranging from 200mm to 500mm. Approximately 64,650 people are served through the sewer system connected to the West WWTP from localities including Sakeb, Raimoon, Ketteh, Nahleh, Al-Haddadeh, Al-Jbarat and the Gaza Camp for Palestinian refugees. The West WWTP is situated southwest of the Gaza Camp and the main line of the West system is Line T with a diameter of 600 mm and a length of 2,380 m. This trunk line collects flow from two other main lines, Line A and Line B. Gaza Camp will be connected to Line T. Line A collects sewage from lower Raimoon, Nahleh and lower Ketteh. The flow is then pumped by the Ain Ad-Deek Pumping Station to Line T through a 300 mm pressure main. The diameters of Line A range from 200 to 400 mm. Line B collects sewage from upper Ketteh, upper Raimoon and Sakeb and connects to Line T at the main street of Gaza Camp near Abu Baker Mosque. The diameters of Line B range from 200 to 500 mm.

### **Previously Proposed Sewers**

Approximately 53 km of new sewers have been designed in 2010 by Orient Engineering Consultancy and Design to serve Al-Jbarat, An-Nabi Hood, Deir Al-Liyat, South Sakeb and small pockets of other areas in the West Jerash system. The wastewater flow collected by these sewers will be discharged primarily to the West WWTP. Flow from An-Nabi Hood will be conveyed by gravity to the East WWTP. As of July 2011, funding has yet to be obtained to construct the proposed sewers.

The proposed sewers range from 200 to 500 mm diameter with a total length of 52,390 m. In addition, there will be 1,291 house connections of 150 mm diameter with a total length of 6,528 m. Actual lengths of designed sewers differ from these preliminary estimates. There are three proposed pump stations. Pump Station 1 (Al-Jbarat) picks up flow from most areas of Dahr As-Srou and Al-Jbarat. Two smaller pump stations collect sewage flows from lower Sakeb and the northeast part of Dahr As-Srou.

List of served localities is shown in Table 11-1.

**Table 11-1: Localities Served with Wastewater Collection and Treatment Systems**

District	Localities	Population 2012	System
Jerash Qasabah	Jarash	32,385	East
	Soof	14,574	East
	Mukhayyam Soof	13,299	East
	Dair Elliyyat	3,029	East
	Meqebleh	2,072	East
	Asfoor	961	East
	Nabi Hood	1,173	East
	Mukhayyam Ghazzeh	17,750	West
	Sakeb	12,771	West
	Raimoon	7,839	West
	Ketteh	7,294	West
	Dahr As-Srou	7,118	West
	Nahleh	3,926	West
	Hadadeh	2,776	West
	Mansheiat Hashem	2,947	West
Ejbarat	2,229	West	
<b>Total Population Served</b>		<b>132,144</b>	
<b>Total Governorate Population</b>		<b>191,700</b>	
<b>% Served</b>		<b>69%</b>	

## Wastewater Treatment:

The governorate has 2 operating WWTPs which are:

**East WWTP:**The plant was originally designed as an extended aeration plant at a capacity of 1,150 m<sup>3</sup>/day, and became operational in 1983. The plant was upgraded to its current capacity of 3,750 m<sup>3</sup>/day in 1993 and included two aeration tanks, one clarifier and two polishing ponds. One aeration tank and one clarifier were not included in the upgrade. Since the current plant has three aeration basins, then the rated flow is 3,750 m<sup>3</sup>/ day and BOD load is 2,415 kg/day. An expansion for the WWTP is committed by WAJ for an average design flow of 9000 m<sup>3</sup>/ day, and average BOD load of 9,900 kg/ day.

**West WWTP:**The plant is located southwest of the Gaza Camp and has a treatment capacity of 9,550 m<sup>3</sup>/day. Construction of the West system was recently completed, and the contractor began operating the WWTP in mid-January 2011. The treatment process is modified extended aeration to provide nitrification/denitrification and phosphorous removal capabilities. The plant is designed for a flow capacity of 9,000 m<sup>3</sup>/d to cater for year 2025 peak day flows in addition to 400 m<sup>3</sup>/d of

septage. The design BOD load of the plant is 7,200 kg/ day. The WWTP consists of the following main units:

- 2 coarse screens and 2 automatic and 1 manual fine screens.
- Combined aerated grit/grease removal unit.
- 400 m<sup>3</sup>/d capacity septage receiving station and tank.
- Parshall flume for flow measurement.
- 2,500 m<sup>3</sup> equalization tank.
- Two 9,600 m<sup>3</sup> oxidation ditches.
- Two 23 m diameter secondary clarifiers.
- Six 10.5 m<sup>2</sup> gravity sand filters.
- Chlorine disinfection unit.
- Sludge thickening and mechanical centrifuges dewatering equipment for treating of 70% of the sludge.
- Sludge drying beds for treating of 30% of the sludge.

Figure 11-2 shows the existing wastewater systems in Jerash governorate.

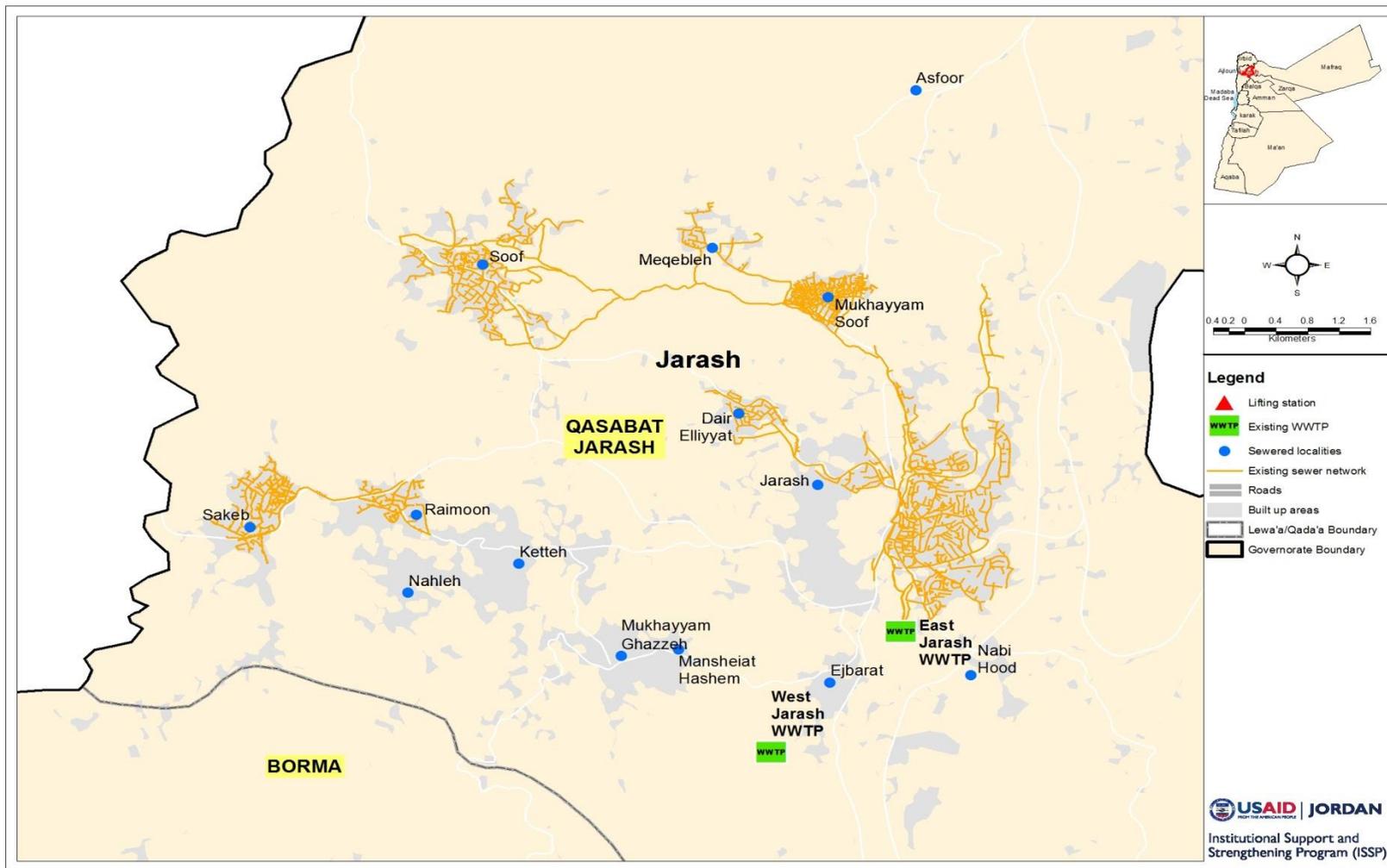


Figure 11-2: Existing Wastewater systems in Jarash Governorate

## Unsewered Areas:

Areas that are not covered with sewer systems are served through septic pits that are likely not sealed. The population that is not covered with sewer systems is approximately 59,556 - 31% of the total population. Approximately 32,584 (55% of the unsewered areas) are located within Jerash District and 11,860 (20% of the unsewered areas) are located within Burma District and 15,112 (25% of the unsewered areas) are located within Al-Mustabah District. The largest 3 localities which have a population of more than 5,000 comprising 31.5% of the unsewered population are Kufr Khall, Baliela, and Burma.

Other localities will continue to use septic pits as there is no history for water pollution or any health problems

Table 11-2 below gives a list of unsewered districts and their current population:

**Table 11-2: Unsewered Districts within Jerash Governorate**

District	Current unsewered Population (2012)	% of Governorate Population
Al-Mastabah	15,112	8%
Burma	11,860	6%
Jarash	32,584	17%

In addition to that, some localities within the served districts are also not covered with sewer systems. Table 11-3 below shows the list of districts. Total estimated number of unsewered population exceeds 40,779.00 excluding the unsewered population within the service areas of sewer systems.

**Table 11-3: Unsewered localities with more than 5,000 population within served districts**

District	Locality	Current unsewered Population (2012)	% of Governorate Population
Jerash	Kofor Khall	7,007	4%
	Baliela	6,195	3%
Borma	Borma	5,575	3%

In this report, localities above 5,000 population are considered for sewer service needs assessment. Total population within these localities is about 18,777 (10% of the governorate population).

Figure 11-3 shows Unsewered localities in Jerash Governorate.

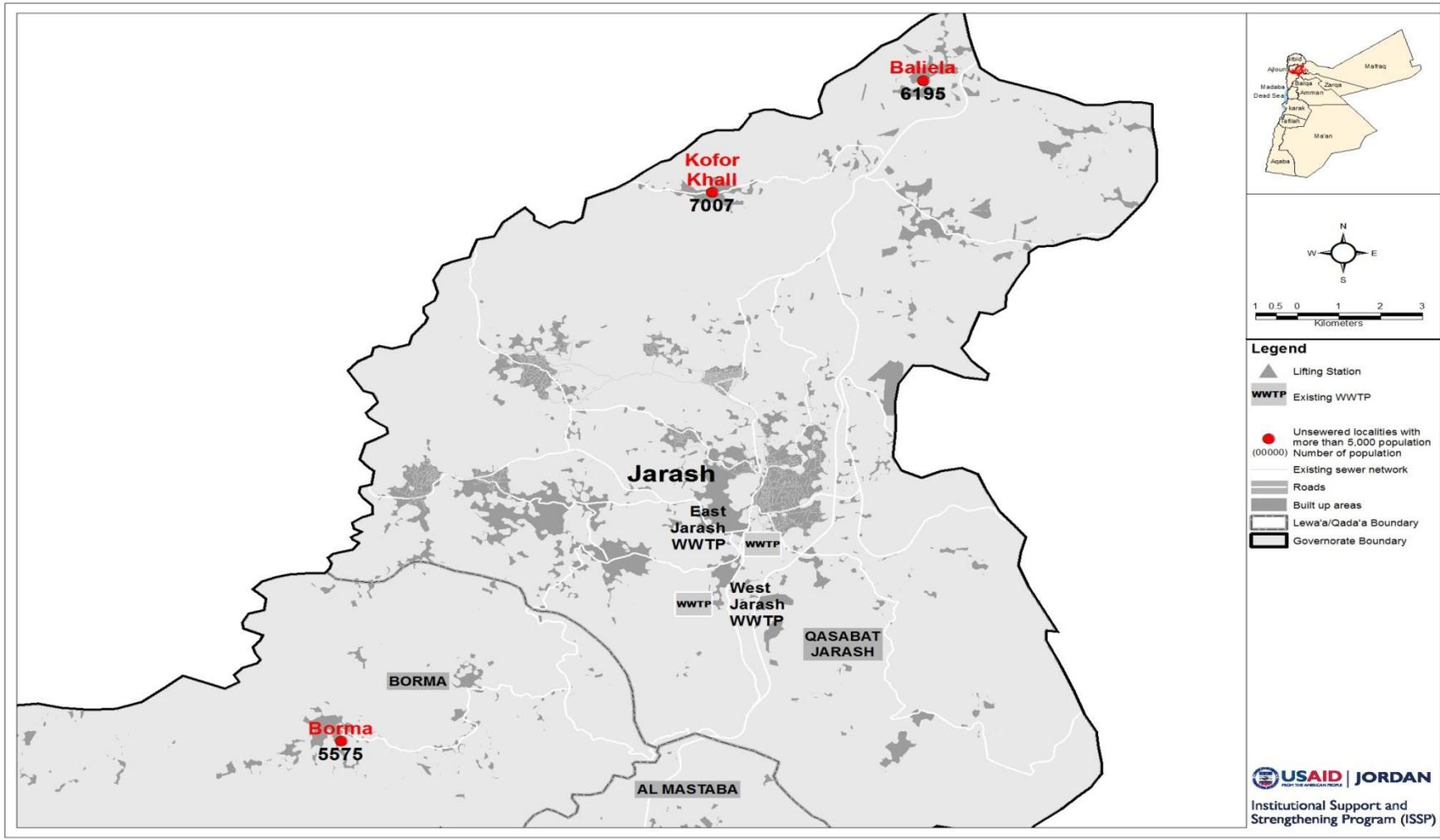


Figure 11-3: Proposed wastewater systems for unserved localities in Jarash governorate

## Projected Wastewater Loads

Table 11-4 below shows the population projections for each of the current served population and unsewered areas. The population projection figures used are based on the WIP numbers that were to estimate water and wastewater loads.

**Table 11-4: Population Projections in Jerash**

Service System	WWTP	Status	Served Pop. on (2012)	% of total Gov. Pop. (2012)	Projected Population				
					2015	2020	2025	2030	2035
East	East WWTP	Existing	67,494	35%	72,220	80,840	90,481	101,264	113,323
West	West WWTP	Existing	64,650	34%	68,941	76,739	85,424	95,098	105,876
Unsewered Localities above 5,000 population	-	Proposed	18,777	10%	20,058	22,391	24,995	27,902	31,147
Unsewered Localities below 5,000 population	-	-	40,779	21%	43,562	48,628	54,283	60,596	67,644

The above population figures were used to develop the wastewater flows and biological loads projections shown in Table 11-5.

**Table 11-5: Projected Wastewater flows and BOD loads in Jerash**

Service System	Projected Wastewater Flow (m <sup>3</sup> /d)				
	2015	2020	2025	2030	2035
East	5,778	6,467	7,238	8,101	9,066
West	5,515	6,139	6,834	7,608	8,470
Unsewered Localities Above 5,000 population	1,605	1,791	2,000	2,232	2,492
Unsewered Localities below 5,000 population	3,485	3,890	4,343	4,848	5,411
Service System	Projected Wastewater load (BOD Kg/d)				
	2015	2020	2025	2030	2035
East	4,622	5,174	5,791	6,481	7,253
West	4,412	4,911	5,467	6,086	6,776
Unsewered Localities Above 5,000 population	1,284	1,433	1,600	1,786	1,993
Unsewered Localities below 5,000 population	2,788	3,112	3,474	3,878	4,329

The table shows that the East WWTP already exceeds the wastewater flow design capacity. As well as the BOD loading whereas the West WWTP, the plant will not reach its design capacities.

## Identification of Wastewater Service Needs Through 2035

### Jerash District

The current service coverage within the city is 67% of the total population of the district whereby 51% is served by the East WWTP by 51% and West WWTP by 49% by the west WWTP. The generated flow from the served areas in Jerash district is about 5,399 m<sup>3</sup>/day to the East WWTP and 5,172 m<sup>3</sup>/day to the West WWTP with a total of 10,572m<sup>3</sup>/day in 2012. The West WWTP can handle the current and projected flow through even 2035 whereas the East WWTP which has a capacity of 3,750m<sup>3</sup>/day is already overloaded both hydraulically and biologically, with still two areas currently not served with a sewer network, namely Kufir Khall and Baliela with 2012 populations of 7,007 and, 6,195 respectively. This new flow and its projection to 2035 has to be incorporated in the future needs.

**Table 11-6: Wastewater Service Needs for Unsewered Localities in Jerash District**

Locality	Current Population	Projected Population (2035)	Collection Wastewater System estimated Length (km)	Wastewater Treatment Needed (m <sup>3</sup> /d)	Estimated Biological Loads (BOD, KG/d)
Kofor Khall	7,007.00	11,623	22	930	744
Baliela	6,195.00	10,276	20	822	658

### Burma District

The current population in Burma district is about 11,860, based on DOS. In Borma district, there is one locality that has a population of more than the urban limit of 5,000 which is the Borma locality with 5,575 people in 2012. The amount of WW generated is about 446m<sup>3</sup>/day in 2012 which is still in the range of the treatment capacity of the West WWTP.

**Table 11-7: Wastewater Service Needs for Unsewered Localities in Borma District**

Locality	Current Population	Projected Population (2035)	Collection Wastewater System estimated Length (km)	Wastewater Treatment Needed (m <sup>3</sup> /d)	Estimated Biological Loads (BOD, Kg/d)
Borma	5,575	9,248	18	740	592

### **Mustabah District**

Population of all localities in Mustabah district are less than 5,000 people, and are therefore outside the planning criteria.

Table 11-8 below illustrates the estimated costs needed to implement required wastewater service needs to accommodate projected loads of the current systems and to expand the wastewater service area to cover localities with more than 5,000 population.

Figure 11-4 shows proposed system priorities for years 2015, 2025, and 2035.

**Table 11-8: Cost Estimate for Wastewater Service Needs in Jerash**

Service System	Item	Investment Cost (Million JD)		
		Immediate (2013-2015)	2016-2025	2026-2035
East WWTP	Expansion of WWTP – additional capacity of 4,250m <sup>3</sup> /d (total needed capacity is 8,000m <sup>3</sup> /d) and additional capacity of 2,800m <sup>3</sup> /d (total needed capacity is 10,800m <sup>3</sup> /d)	-	1.0	3.1
Unsewered localities in Jerash and Borma Districts	Construction of wastewater collection system and house connections Immediate: Kofor Khall, Baliela, and Borma with total length about 60km	-	14.0	6.0
<b>Governorate Total</b>				
Capital Costs		-	<b>15.0</b>	<b>9.1</b>

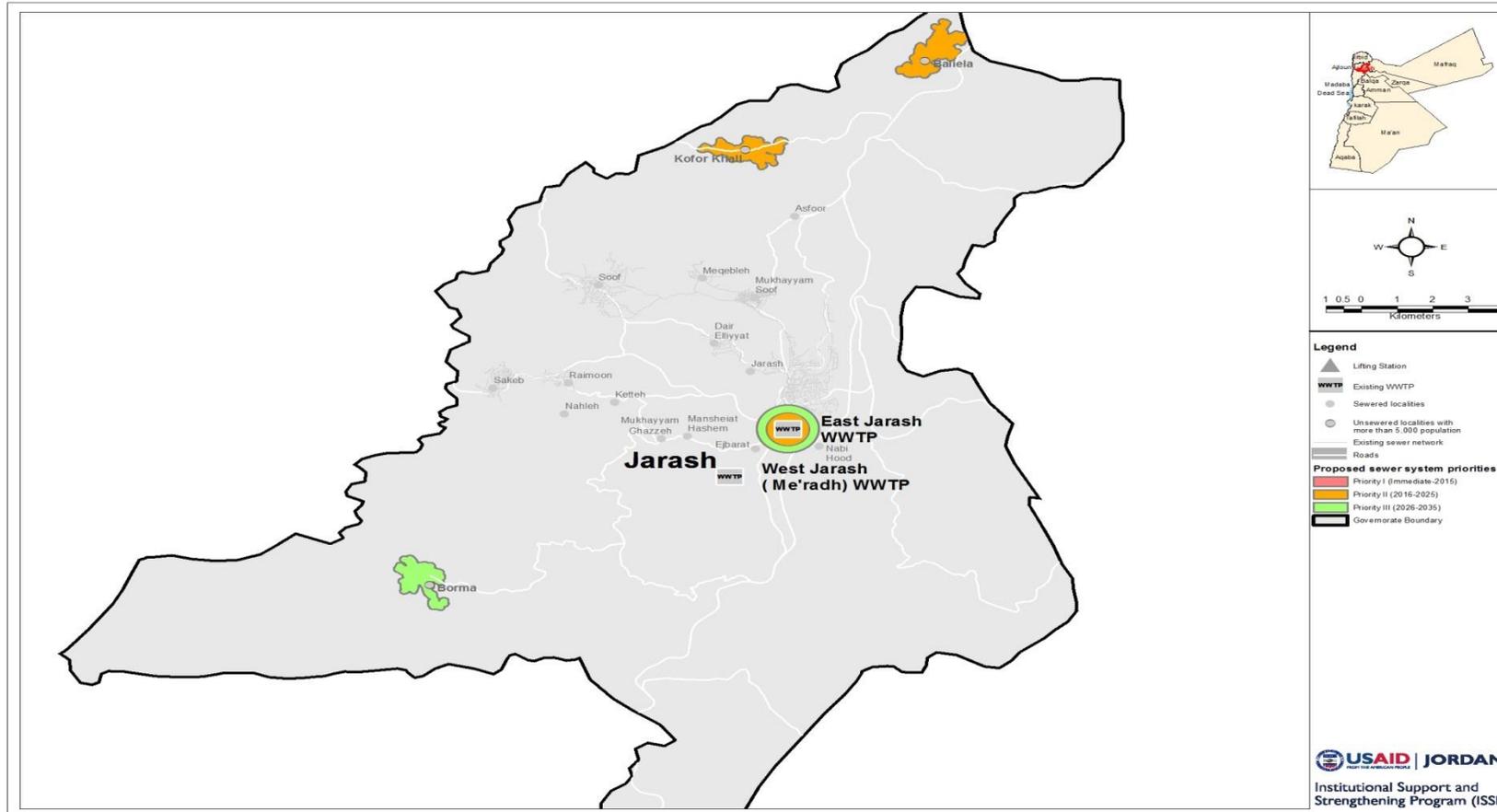


Figure 11-4: Proposed system priorities for Jerash Governorate

# 12 AJLOUN

## Summary of Wastewater Assessment

Ajloun Governorate has a current population of 146,900 (2012) which is projected to grow to 240,400 in 2035, an increase of 64% over the next 23 years. The population is distributed over 55 localities, of which 10 have a population greater than 5,000 with a combined population of 117,200 (80% of the governorate population). The remaining 45 localities have populations less than 5,000 with a total of 29,700 (20% of the governorate population). Currently, 4 localities are served by wastewater collection systems while the remaining 51 are served by septic pits.

Within the sewerred localities collectively only 61,700 people are connected to the sewerage network which represents 42% of the total governorate population. There is one existing wastewater treatment plant with a total design capacity to serve 97,000 people. There is, therefore, capacity available to serve an additional 35,300 people.

Based on the projected population of 202,300 by year 2025 and 240,400 by year 2035, the following wastewater systems and treatment needs are estimated:

	Immediate (to 2015)	Year 2025	Year 2035
Needs	None	<ol style="list-style-type: none"> <li>1. Additional wastewater collection and treatment systems for 61,700 people</li> <li>2. Septage wastewater treatment for 70,900 people (total unsewered population in 2025)</li> </ol>	<ol style="list-style-type: none"> <li>1. Additional (between 2025 and 2035) wastewater collection and treatment systems for 76,200 people</li> <li>2. Septage wastewater treatment for 40,760 people (total population of localities with less than 5,000 population)</li> </ol>
Estimated Costs	0	<ol style="list-style-type: none"> <li>1. 41 million JD</li> <li>2. 7.4 million JD</li> </ol>	<ol style="list-style-type: none"> <li>1. 29 million JD</li> <li>2. 4.3 million JD</li> </ol>

Details of the analysis of the existing situation with respect to wastewater collection and treatment and needed improvements for the future (up to 2035) with associated investment costs are presented in the following sections.

Table below shows estimated cost to cover the expansion of the WWTP and of the existing network for year 2015, and 2025, and 2035.

<b>Governorate Total (MJOD)</b>			
<b>Priority</b>	<b>2012-2015</b>	<b>2016-2025</b>	<b>2026-2035</b>
<b>Capital Costs</b>	-	48.4	33.3

## **Introduction**

Ajloun governorate is located in the Northern region of Jordan, which also includes Irbid, Mafraq, and Jerash governorates. Current population of the governorate is 146,900 which is estimated to grow to 240,400 by 2035. It has a total area of 420km<sup>2</sup> (0.5% of the total Jordan Area) with an average population density of 468person/km<sup>2</sup>.

The governorate has 55 localities distributed in 2 districts:

- Ajloun Qasabah: includes Ajloun, Sakhray, and Orjan sub-districts
- Kufranjah District

Figure 12-1 below shows the governorate districts and localities

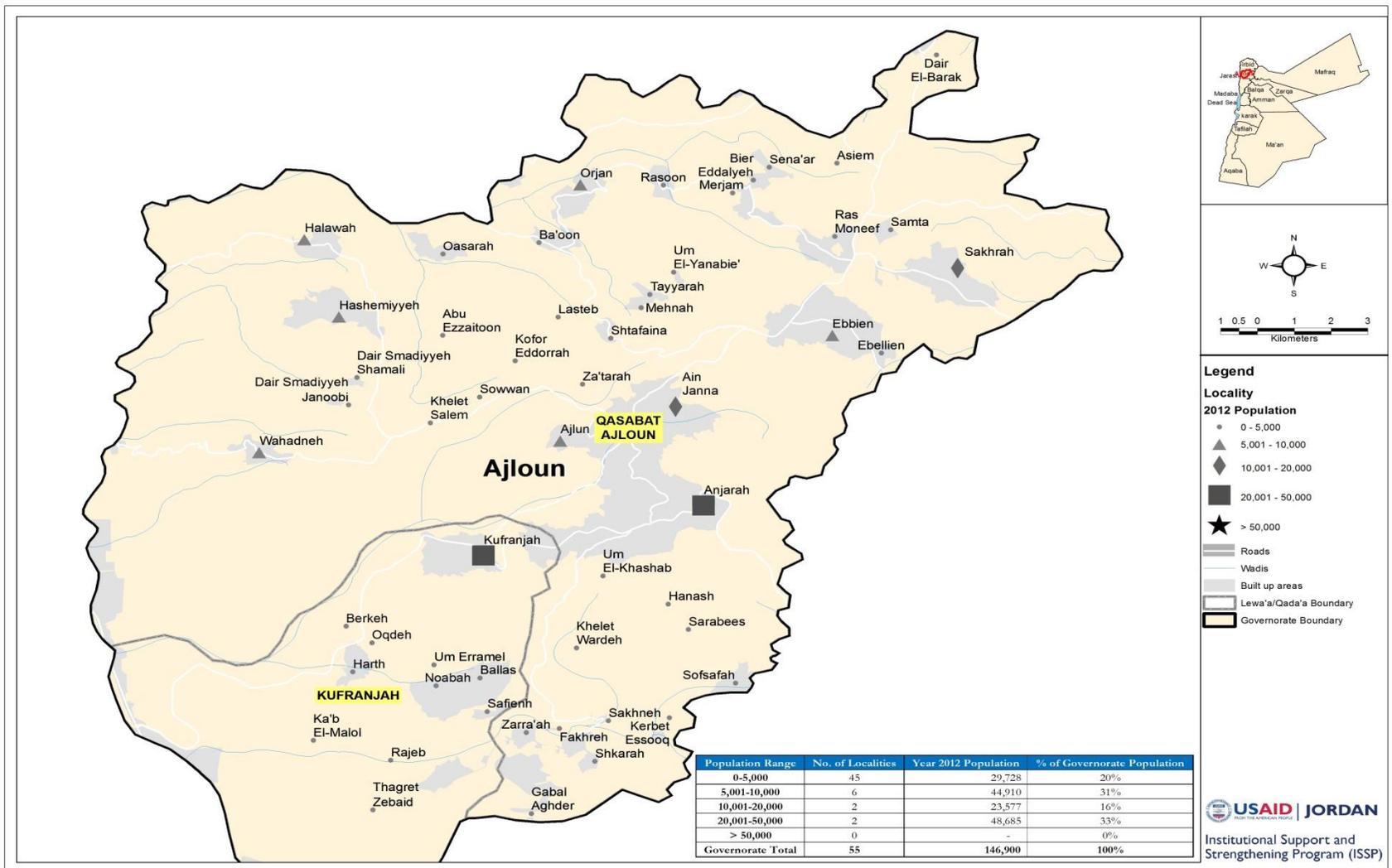


Figure 12-5: Ajloun Governorate Districts and Localities

## Wastewater Service Areas

The existing sewer service areas cover 4 localities within two districts: Ajloun Qasabah, and Kufranjah. The sewer system is connected to Kufranjah WWTP.

**Ajloun Service System:** The system serves a population of approximately 61,700 with 90% coverage within served localities, representing about 42% of the total governorate current population. The system consists of two major interceptors that collect wastewater flows: one is 400mm in diameter and collects sewerage from Ajloun and Ain Janna localities. The other is 300mm in diameter and collects flows from Anjarah. Both are then connected to a 500mm diameter pipeline that also collects wastewater flows from Kufranjah. The list of served localities is shown in Table 12-1.

**Table 12-1: Served Localities in Ajloun**

District	Localities	Population 2012	Estimate Served Population	System
Ajloun Qasabah	Anjarah	21,794	19,615	Ajloun sewer system
	Ain Janna	10,841	9,757	Ajloun sewer system
	Ajlun	9,018	8,116	Ajloun sewer system
Kufranjah	Kufranjah	26,891	24,202	Ajloun sewer system
<b>Total Population Served</b>		<b>61,690</b>		
<b>Total Governorate Population</b>		<b>146,900</b>		
<b>% Served</b>		<b>42%</b>		

## Wastewater Treatment

**Kufranjah WWTP:** This is the only treatment plant in the governorate, located in the center of the within Kufranjah Municipality boundary. It was built in 1989 with a total capacity of 1,900m<sup>3</sup>/d and serves 4 localities. The total current flow is 2,763m<sup>3</sup>/d, which is about 145% of the design hydraulic load. The plant has a biological design load of 1,615kg/d and received a BOD load of 1,458kg/d in 2012 (114% of the design BOD load). The plant currently serves an approximate population of about 61,700 although the design capacity is 24,850. The treatment process includes trickling filters.

WAJ is undertaking an upgrade of the treatment plant to increase the hydraulic capacity to the 9,000m<sup>3</sup>/d and biological design load to 6,300kg/d. The new treatment plant has a design capacity to serve approximately 97,000 people.

The existing Wastewater system in Ajloun Governorate is shown in Figure 12-2.

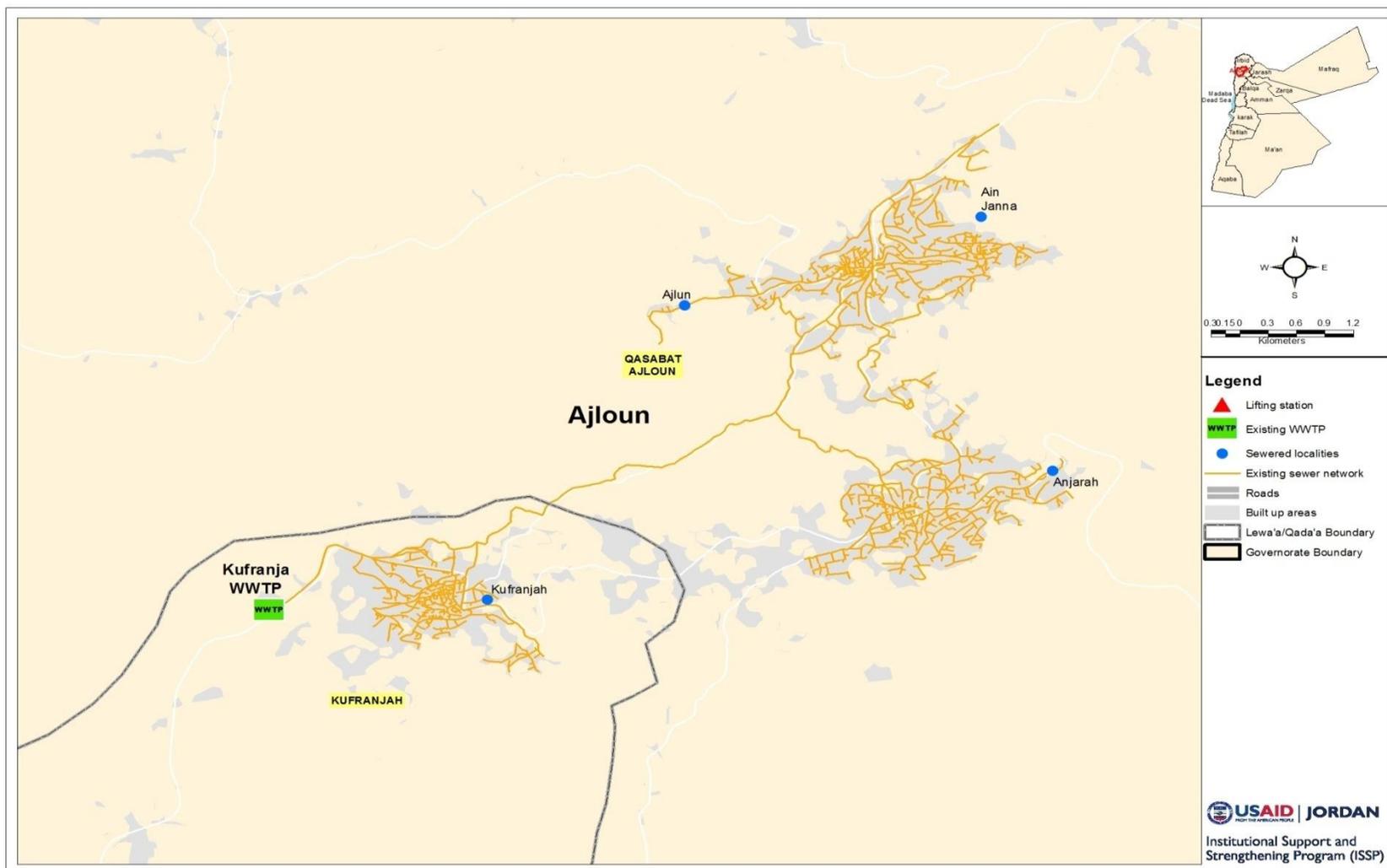


Figure 12-2: Existing Wastewater systems in Ajloun governorate

## Unsewered Areas:

The wastewater network serves the central part of the governorate. The Eastern and Western parts of the governorate contains unsewered localities with populations of more than 5,000. The total population within these localities is approximately 48,630 (33% of the governorate population).

Table 12-2 (below) gives a list of the unsewered districts and their current populations:

**Table 12-2: Unsewered Localities within Ajloun**

District /Locality	Current unsewered Population (2012)	% of Governorate Population
Ajloun Qasabah / Hashemiyyeh	8,056	5%
Ajloun Qasabah / Wahadneh	5,842	4%
Ajloun Qasabah / Halawah	7,042	5%
Ajloun Qasabah / Sakhrah	12,736	9%
Ajloun Qasabah / Ebbien	8,686	6%
Ajloun Qasabah / Orjan	6,266	4%

Unsewered Localities with population of more than 5,000 in Ajloun Governorate are shown in Figure 12-3.

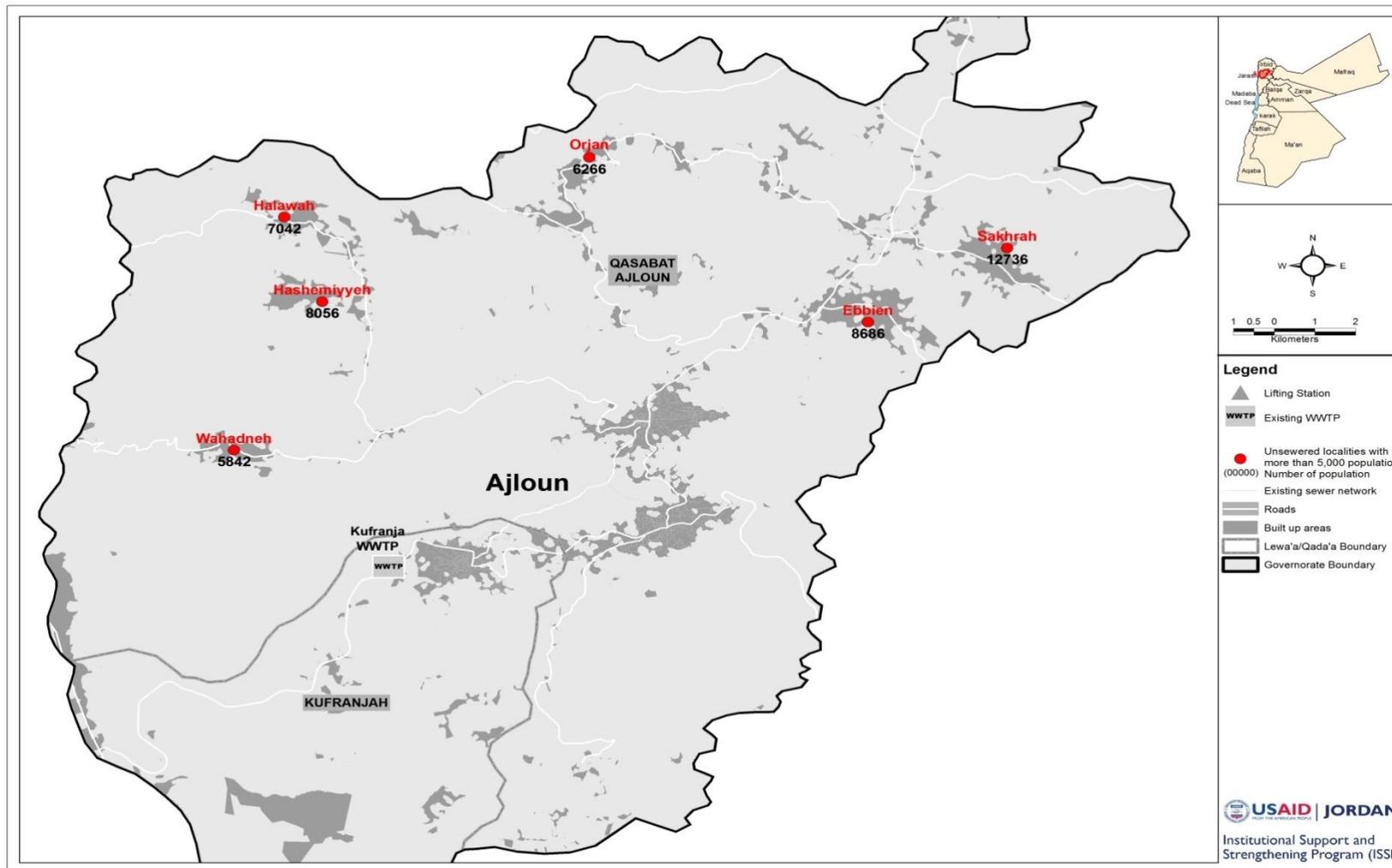


Figure 12-3: Unsewered localities in Ajloun Governorate

## Projected Wastewater Loads

Table 12-3 below shows the population projections for both the current served population and as well populations of unsewered areas.

**Table 12-3: WWTP Status and Population Projections for Ajloun**

Service System	WWTP	Estimated Served Population (2012)	% of total Gov. Population	Projected Population				
				2015	2020	2025	2030	2035
Ajloun	Kufranjah	61,690	42%	65,800	73,267	81,583	90,841	101,151
Unsewered Localities above 5,000								
Hashemiyyeh	-	8,056	5%	8,593	9,568	10,654	11,863	13,209
Wahadneh	-	5,842	4%	6,231	6,938	7,726	8,603	9,579
Halawah	-	7,042	5%	7,511	8,364	9,313	10,370	11,547
Sakhrach	-	12,736	9%	13,585	15,126	16,843	18,754	20,883
Ebbien	-	8,686	6%	9,265	10,316	11,487	12,791	14,242
Orjan	-	6,266	4%	6,683	7,442	8,287	9,227	10,274
Unsewered Localities less than 5,000		36,582	25%	39,020	43,448	48,379	53,870	59,983

The above population figures were used to develop the wastewater flows and biological loads projections shown in Table 12-4.

The Table shows that the projected wastewater flows and biological loadings for the growing population up to 2035..

**Table 12-4: Projected Wastewater flow and BOD Loads in Ajloun**

Service Area	2015	2020	2025	2030	2035
	<b>Projected Wastewater Flow (m<sup>3</sup>/d)</b>				
Ajloun	5,264	5,861	6,527	7,267	8,092
Unsewered Localities above 5,000 population					
Hashemiyyeh	687	765	852	949	1,057
Wahadneh	498	555	618	688	766
Halawah	601	669	745	830	924
Sakhrah	1,087	1,210	1,347	1,500	1,671
Ebbien	741	825	919	1,023	1,139
Orjan	535	595	663	738	822
Unsewered Localities below 5,000 population	3,122	3,476	3,870	4,310	4,799
	<b>Projected Wastewater load (BOD Kg/d)</b>				
Ajloun	4,277	4,762	5,303	5,905	6,575
Unsewered Localities above 5,000 population					
Hashemiyyeh	559	622	692	771	859
Wahadneh	405	451	502	559	623
Halawah	488	544	605	674	751
Sakhrah	883	983	1,095	1,219	1,357
Ebbien	602	671	747	831	926
Orjan	434	484	539	600	668
Unsewered Localities below 5,000 population	2,536	2,824	3,145	3,502	3,899

## Identification of Wastewater Service Needs Through 2035

### Ajloun System:

Kufranjah WWTP was built in 1989 and is currently overloaded. WAJ is currently working on upgrading the plant and is expected to start operations in the next couple of years.

### Unsewered localities with population more than 5,000

Unsewered localities with more than 5,000 population are distributed in the Eastern and Western parts of the governorate Table 12-5 below shows unsewered localities (with population of more than 5,000) and their service needs.

**Table 12-5: Unsewered localities with more than 5,000 population in Ajloun**

Locality	Current Population	Projected Population (2035)	Collection Wastewater System estimated Length (km)	Wastewater Treatment Needed (m <sup>3</sup> /d)	Estimated Biological Loads (BOD, Kg/d)
Hashemiyyeh	8,056	13,209	24	1,000	860
Wahadneh	5,842	9,579	18	770	630
Halawah	7,042	11,547	22	950	750
Sakhrach	12,736	20,883	38	1,700	1,360
Ebbien	8,686	14,242	26	1,200	930
Orjan	6,266	10,274	19	850	670
Hashemiyyeh	8,056	13,209	24	1,000	860

WAJ undertook a design project to serve part of the eastern unsewered localities in Ajloun governorate through a proposed sewer system which also includes localities in Jerash governorate. The proposed system will be connected to Wadi Hassan WWTP which is in the Irbid Governorate. Localities to be served within Ajloun governorate are Sakhrach, Ebbien, Ebellien, and Ras Moneef with a total population to be of 24,700. The estimated construction cost is 24million JDs for sewer collection system, 2million JDs for construction of 2 lifting stations, and 14million JDs to expand Wadi Hassan WWTP<sup>7</sup> with a proposed hydraulic capacity of 6,100m<sup>3</sup>/d up to 2025. Total project cost is 41million JDs.

Table 12-6 below illustrates the estimated costs needed to implement required wastewater service needs to accommodate projected loads of the current systems and to expand the wastewater service area to cover localities with more than 5,000 population.

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<sup>7</sup> "Pre-design, Feasibility Study, Detailed Design, Preparation of Tender Documents of Wastewater Collection, Treatment and Effluent Reuse from Communities of North Jarash and Al-Juneed", Final Report, Engicon, 2012

Table 12-6: Cost Estimate for Wastewater Service Needs in Ajloun

Service System	Item	Investment Cost (Million JD)				
		Immediate (up to 2015)	2020	2025	2030	2035
	Annual Expansion program for wastewater collection and house connections expansion for the existing systems (Average yearly growth up to 2035) 1,700 people/yr @ 303JD/capita	0.52				
Unsewered localities of more than 5,000 people	Construction of wastewater collection: <b>Phase1 (2020):</b> Sakhrah, Ebbien, Sakhrah, Ebbien, Ebellien, and Ras Moneef and Jerash localities  <b>Phase2 (2030):</b> Hashemiyyeh, Wahadneh, Halawah, and Orjan		27		24	
	Treatment Costs needed: <b>Phase1 (2020):</b> Sakhrah, Ebbien, Sakhrah, Ebbien, Ebellien, and Ras Moneef and Jerash localities. <b><i>(Including Cost of Wadi Hassan WWTP Expansion)</i></b>  <b>Phase2 (2030):</b> Hashemiyyeh, Wahadneh, Halawah, and Orjan		14		5	
<b>Governorate Total</b>						
Capital Costs			41		29	
Yearly Expansion programs		0.52				

Figure 12-4 illustrates the needed investment in wastewater collection and treatment thorough 2035 for Ajloun Governorate.

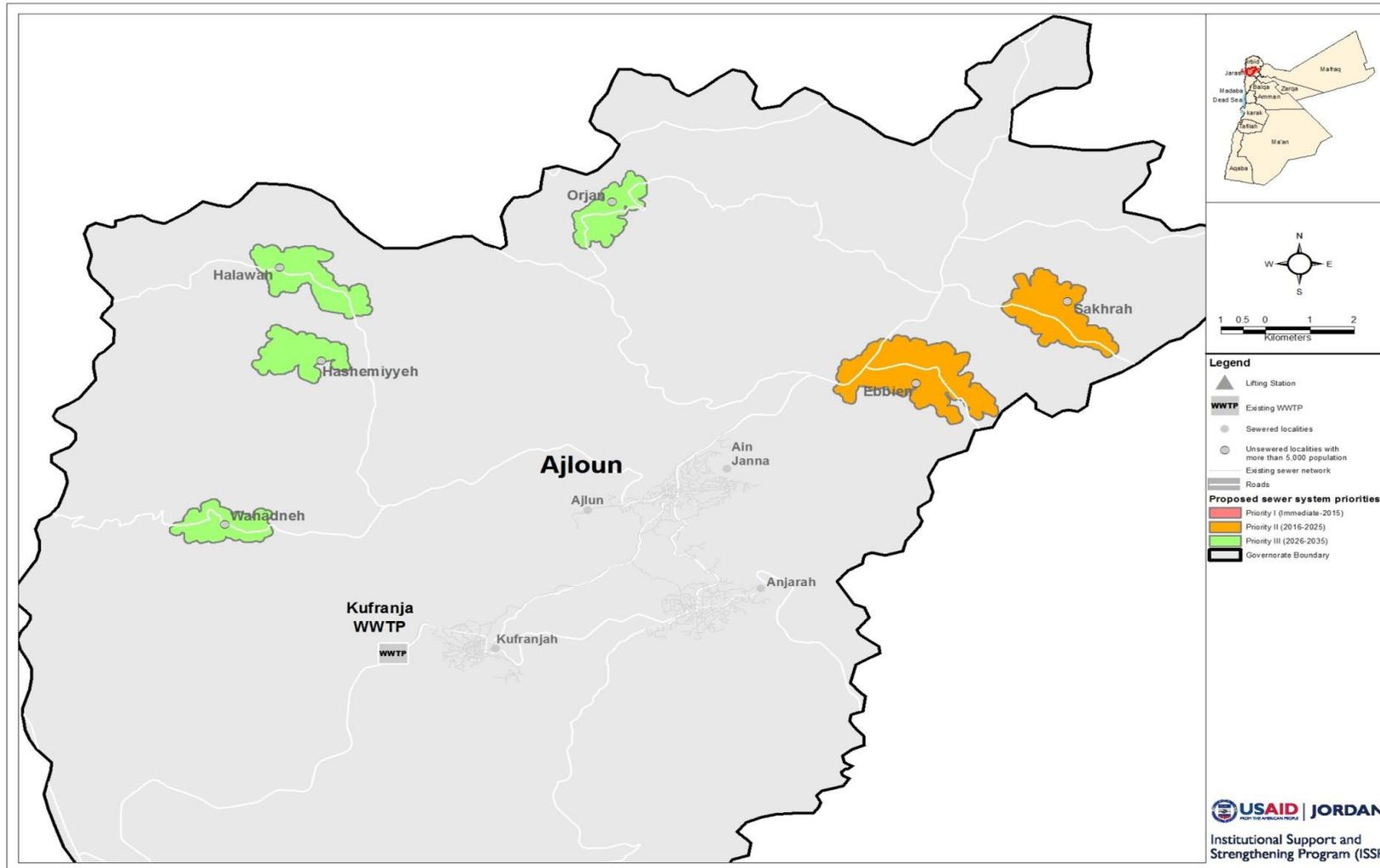


Figure 12-4: Ajloun Governorate Investment Priorities

# 13 KARAK

## Summary of Wastewater Assessment

Karak Governorate has a current population of 249,100(2012) which is projected to grow to 376,250 in 2035, an increase of 51% over the next 23 years. The population is distributed over 115 localities in 10 sub districts of which 12 localities have a population greater than 5,000 with a combined population of 120,825 (49% of the governorate population). The remaining 103 localities have populations less than 5,000 with a total number of 128,275 (51% of the governorate population).Currently, parts of old Karak, Marj, Thallaja and Subeihat in Karak Qasabah district, and the localities of Muta'a, Mazar, Merwed, Adnanyeh, and Median are served with wastewater service (these localities were recently announced for connection). Total population served is approximately 51,000 or 21% of the population. The remaining 108 localities are served by septic pits.

Within the sewerred localities only 15,000 people are connected to the sewer system in Karak city which represents only 6% of the total governorate population. Approximately 36,000 people are currently connected to the sewer system in localities within Mouta'a WWTP service area serving 15% of the governorate population, although the treatment plant has not yet been commissioned.

Karak Governorate has two wastewater systems that serve about 21% of the current population. The first system serves Karak city with service coverage of about 6% of the total governorate population. Karak WWTP is currently operating in excess of design capacity. Therefore WAJ has committed funds for WWTP expansion for a design flow of 5,500m<sup>3</sup>/day and a design BOD load of 3,850 kg/day.

The Second WWTP "Adnanyeh-Mouta'a" serves Mou'ta, Al-Mazar Al-Janoubi, Al Adnaneh, Merwed, and Median and serves 15% of the total governorate population.

These two existing wastewater treatment plants have a total design capacity to serve 123,100 people in year 2035, and one septage plant in Lajoon with design capacity to serve 12,923people.

This means that the existing two treatment plants collectively have available treatment capacity for 93,850 additional people.

Karak city wastewater system was part of the study for upgrading and extension of the wastewater treatment plants as well as the extension and partial renewal of the sewerage networks. A review of the sewerage catchment areas for Karak Qasabah resulted in significant increase in the catchment area that needs to be connected to the Karak WWTP. Both network and the Karak WWTP were designed for the full wastewater flows based on full coverage of the proposed sewerage area, with staged implementation through 2035. Contract packages are ready and awaiting funds for execution.

Eight new localities were identified in this report as service priority considering the number of population to be served, available wastewater designs and tender documents, and closeness of these localities to existing wastewater systems. The considered localities are Ghawr Safi, Qatraneh, Ghawr Al Mazra'a, Ayy, Faqo'e, Qasr, and Tyybeh. Covering these localities, in addition to expansion of the existing Karak system to cover areas within Karak Service areas will increase the service coverage in the governorate to reach about 39% of the total population.

Based on the projected population of 262,921 by year 2015, 314,774 by year 2025, and 376,853 by year 2035, the following wastewater systems and treatment needs and costs are estimated:

	Immediate (to 2015)	Year 2025	Year 2035
Needs	No immediate wastewater systems are envisioned. Funds for Karak WWTP immediate expansion has been committed by WAJ for tendering procedure. Maintenance and rehabilitation of sewer networks and WWTP	<ol style="list-style-type: none"> <li>1. Collection network to serve Karak City and 18 localities.</li> <li>2. Collection network in Mouta'a (69km)</li> </ol>	<ol style="list-style-type: none"> <li>1. Collection network for Qatraneh locality (23.5km)</li> <li>2. Collection network for Ghawr Safi and Qasr and Rabbah (36.6km)</li> <li>3. Connection systems for Ghawr Mazra'a, Faqo'e and Serfa, and Ayy and Tayybeh (81km)</li> <li>4. Karak WWTP stage 1 expansion</li> <li>5. Mouta'a WWTP expansion</li> </ol>
Estimated Costs	0.8 million JD	<ol style="list-style-type: none"> <li>1. 15.8 million JD</li> <li>2. 16.6 million JD</li> </ol>	<ol style="list-style-type: none"> <li>1. 6.8 million JD</li> <li>2. 36.6 million JD</li> <li>3. 24.2 million JD</li> <li>4. 3 million JD</li> <li>5. 3.3 million JD</li> </ol>

Cost to cover the expansion of the WWTP and network expansion for year 2015, and 2025, and 2035 are estimated as shown in the following summary table below.

<b>Governorate Total (MJOD)</b>			
Priority	2012-2015	2016-2025	2026-2035
Capital Costs	0.8	32.4	73.9
Yearly Expansion programs	0.75 yearly		

Other small localities will need to continue the current practice of discharging domestic wastewater flows to the septic pits if there were no records for health or water pollution problems.

## **Introduction**

Karak governorate is located south-west of Amman, with Al Karak city as its major urban center. It borders Madaba and the Capital governorates to the north, Ma'an Governorate from the east, Tafilah Governorate from the south, and the Dead Sea from the west. The Karak governorate is situated along the south eastern coast of the Dead Sea and the mountain chain known as the Mountains of Moab. The cities in the governorate are located at elevations ranging from over 1000 meters above sea level in the South Mazar District to 800 meters above sea level in the northern Districts to about 350 meters below sea level at Ghour Al Safi Area. The governorate is connected to the rest of Jordan by two highways: the Kings Highway and the Desert Highway. The governorate area is 3217km<sup>2</sup>, and the population density is 66.6 person/ km<sup>2</sup>. The total current population is 249,100. This population is estimated to grow to 362,689 by 2035.

About (55%)of the population is located to the middle and south part of the governorate in Karak Al Qasabah and Al Mazar Al Janoobee sub districts on about45% of the governorate area, the remaining 8 sub districts are Al Ghour Al Janoobee, Al Qaser, Ghour Al Safi, Faqo'e, Ayy, Moua'ab, Moujeb, and Qatraneh sub districts. Although Qatraneh sub district accounts for 3.6% of the population of the governorate, it comprises about 35% of the governorate area. This sub district has the lowest population density of 8 person/km<sup>2</sup>. Figure 13-1 shows Karak governorate districts and localities.

Karak governorate has 112 localities distributed over 10 sub districts:

- Karak Al Qasabah
- Al Mazar Al Janoobee
- Al Ghour Al Janoobee
- Al Qaser
- Ghour Al Safi
- Faqo'e
- Ayy
- Moua'ab
- Moujeb
- Qatraneh

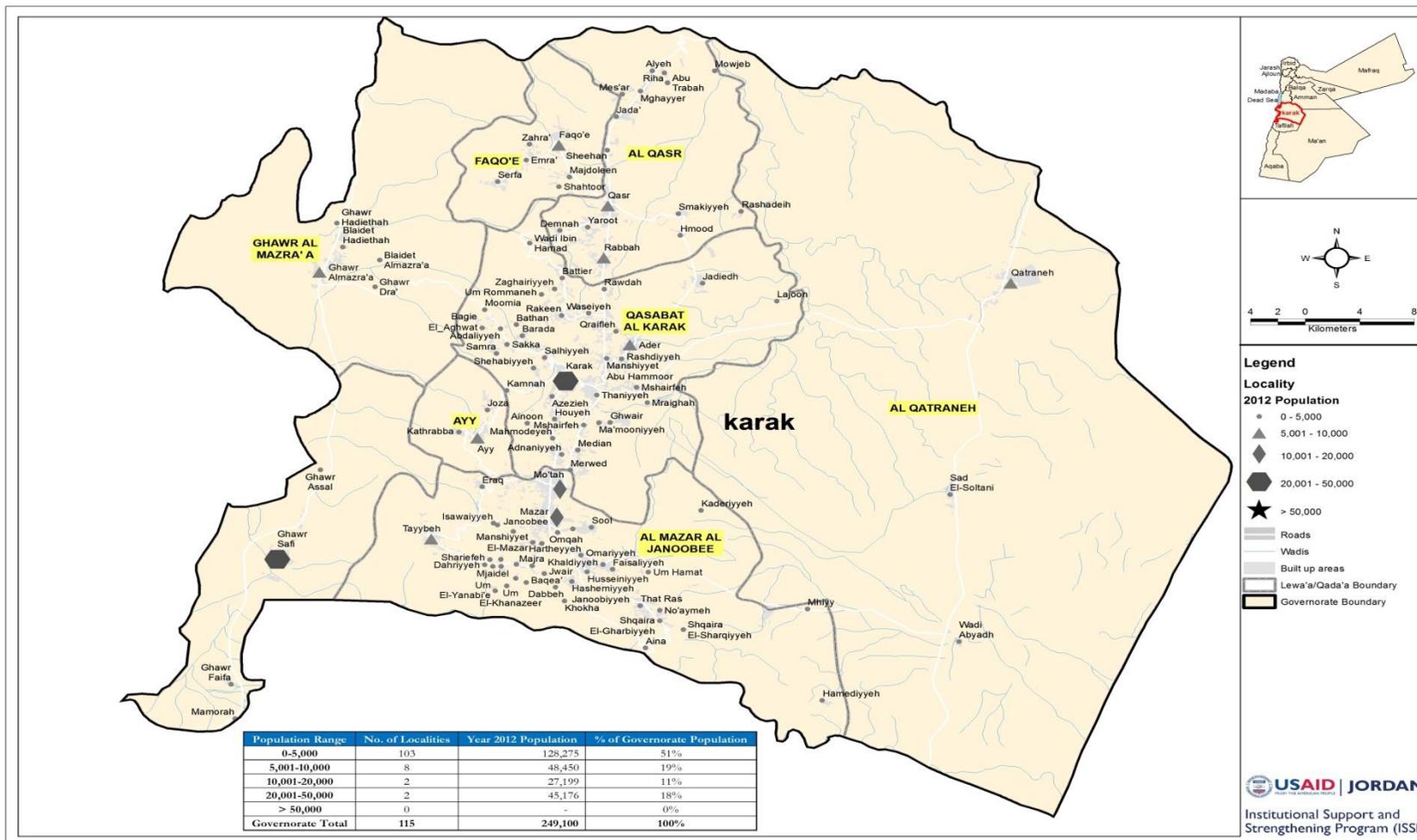


Figure 13-1:Karak Governorate Districts and Localities

## **Wastewater Service Areas:**

The existing sewer service areas cover only localities within two sub-districts: Karak and Al Mazzar Al Janoobe with a total service coverage of about 21% of the total governorate population. The sewer systems in the governorate are served through two WWTPs; Karak WWTP and newly operated Mouta'a-Merwed WWTP. Another septage WWTP is located in Al Lajoon within Karak Qasabah sub district. This plant has recently been expanded.

The population of 81,699 which is expected for year 2035 covers Karak city and 18 other localities in the governorate, namely Karak city Mansheyyet Abu Hammour, Shehabeyya, Aziezieh, Ader, Zahoum, Al Ghwier, El Hawia/Houyeh, Rashdiyyeh, El Baqei, Samra, Barada, Mshairfeh, Saka, Mamouniya, Ainoon and Kamnah.

### **Karak Service Area**

Karak City, is the biggest locality within the governorate and is part of Karak Qasabah sub-district.

It has a population of 24,741 (10% of the governorate population). About 15,000 are served through the sewer system connected to Karak WWTP. A detailed design for upgrading and extension of Karak wastewater treatment plant as well as the extension and the partial renewal of the sewerage networks in Karak was recently conducted by Dorsch Consult/Engicon/GITEC. In the design report, 11 new localities were included within the catchment area of Karak WWTP. Figure 13-2 shows the Karak WWTP new catchment area. Projected population for year 2035 for Karak WWTP service area is 69,102. About 5% will continue to use septic tanks. Karak WWTP design daily flow rate is 7,345 m<sup>3</sup>/d, and a BOD of 865mg/l.

The existing sewerage system covers only the urban areas of old Karak, Marj, Thallaja and Subeihat. The rest of Karak city areas are not sewered. The total length of the existing sewerage network is about 37 km. The network was constructed in two phases. In 1986/89 about 32 km were constructed in Old Karak, Marj and Thallaja. In 1999 about 5 km were added in the Marj area and connected to the existing sewerage network. The diameters of the existing sewerage network range from 200 mm to 400 mm. Sewer from eastern Karak and from western Karak flow by gravity to a point where they join together. To transfer the flow from east to west of the saddle close to Thallaja, a 300m tunnel was drilled with an inside pipe diameter of 300mm. After this junction the pipe diameter increases to 400 mm until it reaches the flushing tank which contains a screen and allows some grit removal; valves are provided to facilitate flushing the siphon at the downstream of the flushing tank. The existing main sewer lines transferring the collected sewage from the flushing tank

to Karak WWTP is an inverted siphon with two parallel pipes: DN200 and DN150. The total length of new sewer lines required to service the complete catchment area is around 220 km of which 118.6 km are included in the preliminary design. For the future flows, the inverted siphon will be retained, but the DN150 pipe will be replaced with a DN 300 pipe. Contract packages for the expansion of the WWTP service area are ready for tendering to start execution.

### **Merwed-Mouta'a Service Area**

The second wastewater service area which has been recently served by Mouta'a WWTP, encompasses the localities of Muta'a, Mazar, Merwed, Adnaneh, and Median. The total population to be connected to the system is approximately 36,000 serving about 15% of the population. Merwed WWTP design daily flow rate is 7,060m<sup>3</sup>/d with BOD of approximately 7000kg/d. Information relating to wastewater networks for the service area of the WWTP is not available. The projected population for year 2035 is 67,878 people and the plant has capacity to serve 107,700 people.

### **Al Lajoun Service Area**

Information relating to the service area for Al Lajoun WWTP is not available as the plant serves tankers from all over the governorate. The septage plant is a stabilization ponds plant with flow design capacity of 1000m<sup>3</sup>/d, and a BOD design load of 1500kg/d.

## **Wastewater Treatment:**

**Karak WWTP:** The plant was constructed in 1999 and was originally designed for an average flow of 800 m<sup>3</sup>/d and a BOD load of 850 kg/d. Currently the average wastewater flow is a little over 1500 m<sup>3</sup>/d and this will increase with the extension of the sewage network by the design horizon of 2035 to 5650 m<sup>3</sup>/d in the low flow scenario or 8000 m<sup>3</sup>/d in the high flow scenario. Therefore, the plant is currently operating over its capacity and upsizing and upgrading of the plant is of immediate priority.

The new capacity of the treatment plant (Extension) has been divided into two stages. A first stage will have a treatment capacity of 5500 m<sup>3</sup>/d, corresponding to a low flow scenario and in a second stage the capacity will be increased to 8000 m<sup>3</sup>/d, corresponding to a high flow scenario with a design load for BOD of 4489kg/d.

The general concept of the treatment process comprises mechanical, biological and tertiary treatment of the sewage water and dewatering or drying of the sludge. The biological treatment is based on continuous flow activated sludge process, designed for nitrification and denitrification to achieve the required effluent nitrogen standards. The wastewater treatment process comprises of preliminary

treatment, biological treatment, tertiary treatment, sludge treatment, and includes other facilities and services for operation including automatic control and management of the electromechanical equipment plant by the associated PLC, linked to the SCADA system.

Five pump stations are required to collect the flow from different parts of the project areas. These are:

1. Manshiet Abu Hamour needs two pump stations:
  - PS4 in the north east of Ader
  - PS5, serving the north west of Manshiet Abu Hammour
2. Thanyah needs two pump stations:
  - PS 3 in the north east of of Zahoum
  - PS1 serving the west area of Thanyah
3. PS2 located to serve Salhya and Shehabya.

The Extension and Upgrade of Karak WWTP project is packaged to four contracts, Contract 1 Karak WWTP Contracts 2, 3 & 4 Sewerage Extensions. The cost estimate of the project is 21.4 M JOD (4.8 for WWTP+16.7 for Sewerage Extensions).

**Merwed-Mouta'a WWTP:** The plant was recently constructed and commissioned to serve the Localities of Muta'a, Mazar, Merwed, Adnaneyeh, and Median, including Mouta'a university. Details for the WWTP are not available. The system serves approximately 39,000 or 16% of the population. Merwed WWTP design daily flow rate is 7,060m<sup>3</sup>/d with BOD load of 5,295 Kg/day.

**Lagoon Septage WWTP:** The plant was constructed as a natural treatment plant that receives wastewater loads from Tankers only. The plant serves Karak Qasabah and adjacent villages. Details for this WWTP are not available, though it was recently expanded.

Figure 13-2 shows existing wastewater systems in Karak governorate.

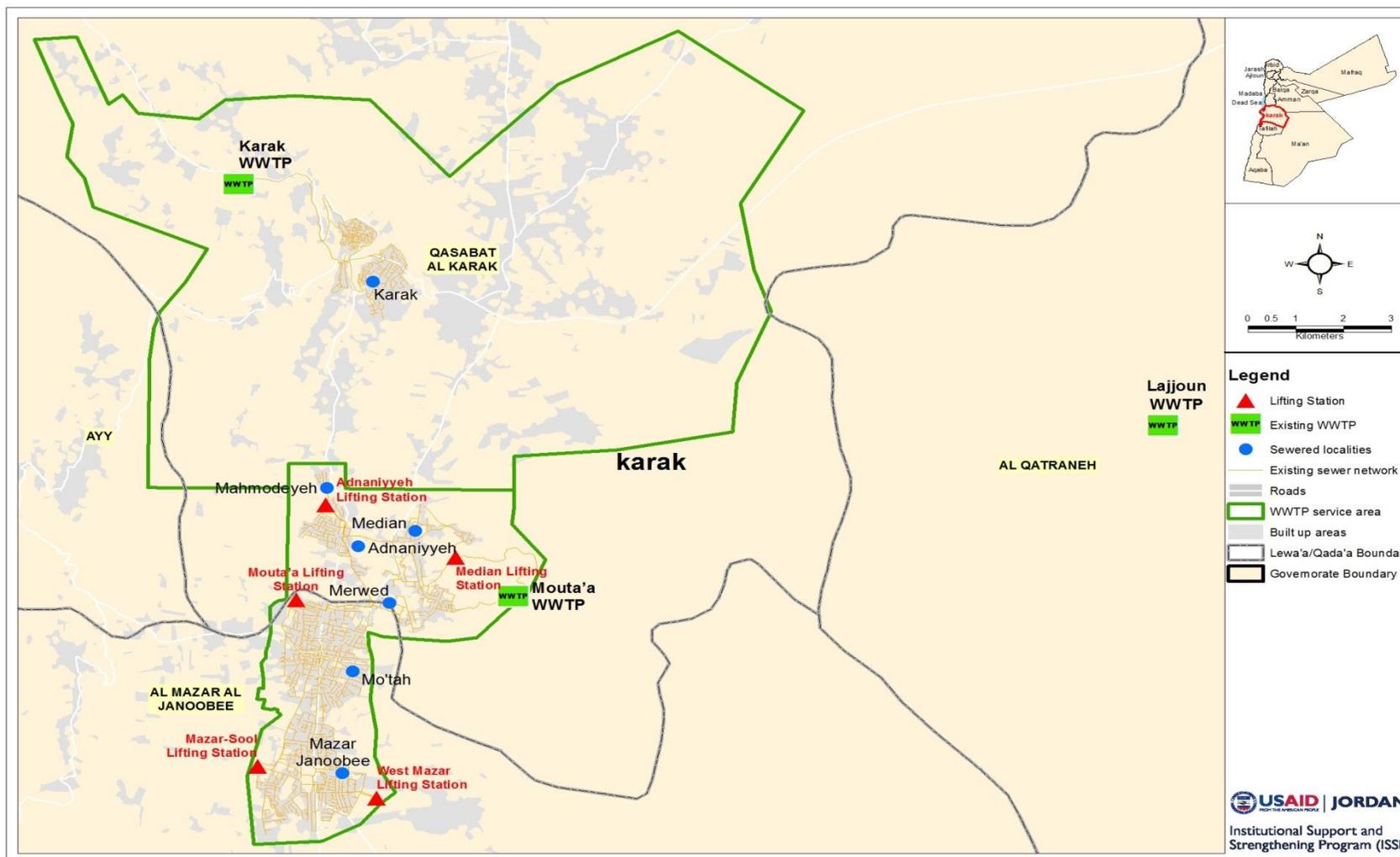


Figure 13-2: Existing Wastewater systems in Karak governorate

## Unsewered Areas:

Areas that are not covered with sewer systems are served through septic pits that are likely not sealed. The population that is not covered with sewer systems is approximately 144,000 or 58% of the total population. About 23,000 people (9% of the unsewered areas) are located within Karak WWTP service area in localities with less than 5,000 inhabitants. The remaining population is distributed on small localities all over the governorate. The largest unserved localities which have population of more than 5,000 are Tayybeh, Qasr, Rabbah, Ghour Safi, Ghour Al Mazra'a, Faqo'e, and Qatranah with approximately 67,000 inhabitants or 29% of the governorate population.

Other localities will continue to use septic pits as there is no history for water pollution or any health problem.

**Table 13-1: Unsewered localities with more than 5,000 population**

District	Locality	Current unsewered Population (2012)	% of Governorate Population
Karak Qasabah	Karak city	11,100	4.4%
Aghwar Janoubeyeh	Ghawr Safi	20,435	8.2%
Qatranah	Qatranah	5,981	2.4%
Aghwar Janoubeyeh	Ghawr Al Mazra'a	8,423	3.4%
Ayy	Ayy	5,873	2.4%
Faqo'e	Faqo'e	5,984	2.4%
Qasr	Qasr	5,424	2.2%
Al-Mazar Al-Janoubee	Tyybeh	6,114	2,5%
Qasr	Rabbah	5,582	2.2%

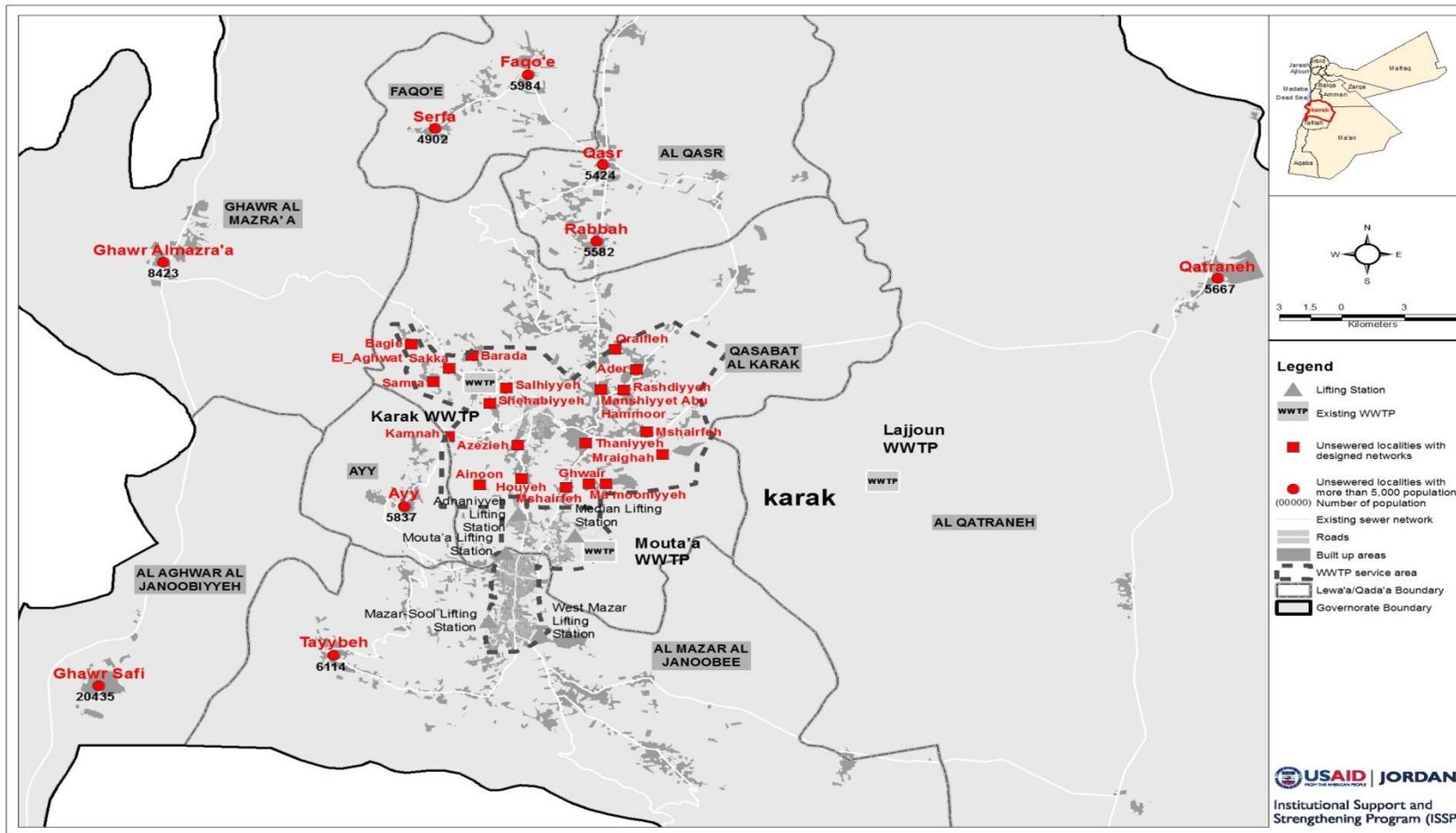


Figure 13-3: Unsewered Localities in Karak governorate

## Projected Wastewater Loads

Table 13-2 below shows the population projections for each of the current served population and unsewered areas. The population projection figures were used to estimate wastewater loads.

**Table 13-2: WWTP Status and Population Projections in Karak**

Service System	WWTP	Status	Served Population (2012)	Projected Population		
				2015	2025	2035
Karak	Karak WWTP	Existing	15,000	61,107	70,650	81,699
Merwed-Mouta'a	Merwed-Mouta'a WWTP	Existing	36,000	46,167	55,200	67,878
Ghour Safi	-	Proposed		21,829	27,202	33,987
Ghour Al Mazra'a	-	Proposed		8,998	11,212	13,972
Qasr-Rabbah		Proposed		11,629	14,651	18,256
Faqo'e- Serfa		Proposed		11,887	14,491	18,051
Qatranah		Proposed		6,054	7,544	9,400
Unsewered Localities below 5,000 population	-	-		103144	117517	131628

The above population figures were used to develop the wastewater flows and biological loads projections shown in Table 13-3.

**Table 13-3: Wastewater flows and biological loads projections in Karak**

Service Area	Projected Wastewater Flow		
	2015	2025	2035
Karak	6,648	7,517	8,365
Merwed-Mouta'a	5,023	5,873	6,950
Ghour Safi	2,428	2,746	2,980
Ghour Al Mazra'a	1,000	1,131	1,255
Qasr-Rabbah	1,306	1,478	1,640
Faqo'e- Serfa	1,293	1,462	1,623
Qatranah	673	761	844
Unsewered Localities below 5,000 population	11,222	12,503	13,478
	Projected Wastewater Load		
Karak	3,972	4,592	5,310
Merwed-Mouta'a	3,001	3,588	4,412
Ghour Safi	1,459	1,678	1,892
Ghour Al Mazra'a	598	691	797
Qasr-Rabbah	781	903	1,041
Faqo'e- Serfa	773	893	1,030
Qatranah	402	465	536
Unsewered Localities below 5,000 population	4,125	4,701	5,265

Table 13-3 shows that the Karak WWTP will exceed the wastewater flow design capacity in 2035 by 4.5%. Projected BOD load will also exceeds the design capacity in 2025 by about 2%. As for Merwed- Mouta'a WWTP, the information is not available to assess projected wastewater flows and BOD load for 2035.

## Identification of Wastewater Service Needs Through 2035

### Karak sub-district

The service coverage for year 2035 within Karak sub-district is about 74.2% serving a population of 131,227. A total of 33,857 are not served in 17 localities with population less than 5,000. The Karak WWTP sewer system serves 20.5% of the current governorate population. The design capacity for the extension and upgrading of Karak WWTP is sufficient for the horizon of 2025.

Improvements were identified in the design report for Karak wastewater system done by Dorsch Consult/Engicon/GITEC, to include the replacement of the existing siphon sewer line that transfers the flow to the WWTP with a diameter of 500 mm. Also the existing sewer line M with a diameter of 200 mm will be replaced by a new sewer line with a diameter of 400 mm. Additionally, five pump stations are required to collect the flow from different parts of the project areas with about 2.5km force main pipes ranging from 200 to 400 mm in diameter.

The treatment plant will be constructed in two stages. In the first stage, the plant will have a treatment capacity of 5500 m<sup>3</sup>/d, and in the second stage the capacity will be increased to 8000 m<sup>3</sup>/d. The second stage estimated cost is about 3.0 MJOD.

According to the discussions with the technical directorate in Karak, there were some urgent needs for maintenance and rehabilitation of existing sewer networks and for Karak WWTP and Lajjoun lifting station with total approximate cost of 0.8 million JD.

### Merwed-Mouta'a

The plant was recently constructed and commissioned to serve the localities of Muta'a, Mazar, Merwed, Adnaneyeh, and Median, including Mouta'a University. Details for the WWTP are not available.

The projected population for the Mouta'a WWTP System for year 2035 is 67,878 with a population increase in the service area of about 27,500. It is envisaged that an extension for the WWTP is required in the horizon of 2030 at an estimated cost of 3.3 MJOD. It is also envisaged that by year 2035, expansion for the wastewater networks will be required with about 68.8 km at 16.6 MJOD.

### **Ghour Safi**

The second biggest community in the governorate is located about 35 km south west Karak city in the Jordan valley. Its current population is 20,435. Projected population for 2035 is 33,879. This projected population will result in a wastewater flow of 2980 m<sup>3</sup>/day. The estimated length of the sewer system including the house connections is estimated to be 84.7 km using 2.5 m network/person. The estimated cost is about 20.5 MJOD. WWTP costs are about 3.3 MJOD.

### **Ghour Al Mazra'a**

Ghour Al- Mazra'a community is located in the Jordan valley, and it is about 20 km to the west of Karak. Its current population is 8,423. Projected population for 2035 is 13,972. This projected population will result in a wastewater flow of 1255 m<sup>3</sup>/day. The estimated length of the sewer system including the house connections is estimated to be 34.9 km using 2.5 m network/person. The estimated cost is about 8.5 MJOD. WWTP cost is about 1.4MJOD.

It is worth to mention that we received information that an existing septage plant is currently constructed in this locality by the Hashemite fund, but the Potash company is funding an evaluation study for this plant.

### **Qasr-Rabbah**

Qaser and Rabbah are two communities located 16 km, and 11 Km to the north of Karak city respectively. The current population for both communities is 11,006. Projected population for 2035 is 18,256. This projected population will result in a wastewater flow of 1,640 m<sup>3</sup>/day. The length of the sewer system including house connections is estimated to be 45.6 km using 2.5 m network/person. The estimated cost is about 11.05 MJOD. WWTP cost is about 1.8 MJOD.

### **Faqo'e- Serfa**

Faqo'e and Serfa are two communities located 20 km, and 18 Km to the north and to the north west of Karak city respectively. The current population for both communities is 10,886. Projected population for 2035 is 18,051. This projected population will result in a wastewater flow of 1,623 m<sup>3</sup>/day. The projected length of the sewer system including the house connections is estimated to be 45.6 km using 2.5 m network/person. The estimated cost is about 11.05 MJOD. WWTP cost is about 1.8 MJOD

## Qatranah

Qatranah community is located about 40 km to the east of Karak city. Its current population is 5,667. Projected population for 2035 is 9,400. This projected population will result in a wastewater flow of 844 m<sup>3</sup>/day. The estimated length of the sewer system including the house connections is estimated to be 23.5 km using 2.5 m network/person. The estimated cost is about 5.7 MJOD. WWTP cost is about 1.1 MJOD.

## Ayy& Tayybeh

Ayy and Tayybeh are two localities located about 10 km to the west and about 20 km to the south of Karak city, respectively. The current population is 5,837, and 6,114 respectively. Ayy is closer to Karak WWTP service area. This locality was not included in the design report for the Extension of Karak WWTP. Tayybeh locality is rather urban and is about 18 km south west of Ayy. Projected population for both localities for year 2035 is 19,824. It is envisaged to serve the two localities by septage plant with capacity of 1,700 m<sup>3</sup>/day. The cost estimate is about 1.5 MJOD.

Figure 13-4 shows proposed wastewater system priorities for years 2015, 2025, and 2035.

## Investment Cost and Priorities

Table 13-4 below shows the estimated investment cost for Karak governorate.

**Table 13-4: Estimated investment cost for Karak governorate**

Service System	Item	Investment Cost (Million JD)		
		2012-2015	2016-2025	2026-2035
Karak	Karak system (trunk,PS, collection sewer, house connection)	-	15.8	-
Karak	Karak WWTP	-	-	3.0
	Maintenance and Rehabilitation of sewer networks and WWTP	0.8		
Mouta'a	Mouta'a system; WWTP future extension	-	-	3.3
Mouta'a	Mouta'a system (trunk, collection sewer, house connection)	-	16.6	-
Ghour Safi	New WWTP	-	-	3.3
Ghour Safi	collection system	-	-	20.5

Service System	Item	Investment Cost (Million JD)		
		2012-2015	2016-2025	2026-2035
Ghour Mazra'a	New WWTP	-	-	1.4
Ghour Mazra'a	collection system	-	-	8.5
Qasr-Rabbah	New WWTP	-	-	1.8
Qasr-Rabbah	collection system	-	-	11.0
Faqo'e-Serfa	New WWTP	-	-	1.8
Faqo'e-Serfa	collection system	-	-	11.0
Qatranah	New WWTP	-	-	1.1
Qatranah	collection system	-	-	5.7
Ayy-Tayybeh	New septage WWTP	-	-	1.5
Karak	Annual program for collection sewers and house connection expansion (1500 people/yr @ 303JD/capita)	0.45yearly (2010-2035)		
Mouta'a	Annual program for collection sewers and house connection expansion (1000 people/yr @ 303JD/capita)	0.30yearly (2010-2035)		
Capital Costs		<b>0.8</b>	<b>32.4</b>	<b>73.9</b>
Yearly Expansion programs		<b>0.75 yearly</b>		

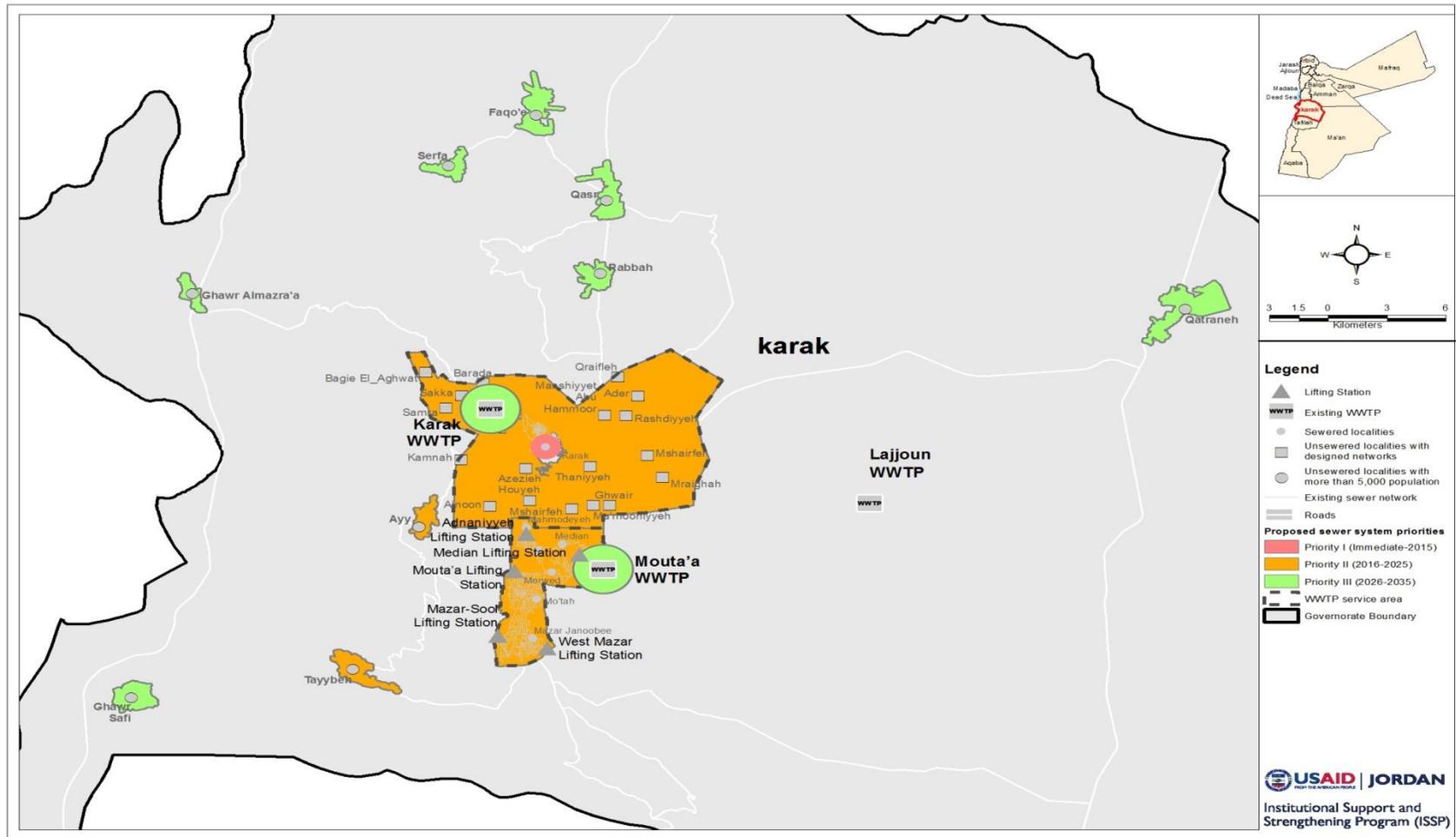


Figure 13-4:Karak Governorate Investment Priorities

# 14 TAFILAH

## Summary of Wastewater Assessment

Tafilah Governorate has a current population of 89,400 (2012) which is projected to grow to 151,733 in 2035, an increase of 70 % over the next 23 years. The population is distributed over 41 localities in three districts. There are six localities with populations greater than 5,000 with a combined population of 68,452 (77% of the governorate population). The remaining 35 localities have populations less than 5,000 with a total number of 20,562 (23% of the governorate population). Currently, Tafilah city center and its expansions including parts of Ruwaym, Eis, and Tafilah Technical University in Tafilah Qasabah district are served with a wastewater system. Total population served is approximately 27,700 or 31% of the population. The remaining 35 localities are served by septic pits.

Tafilah Governorate has one wastewater system which serves Tafilah city and parts of Ruwaym, and Eis through two East and West interceptors which flow to the WWTP. Four pump stations transfer the flow to the East interceptor. Service coverage of the system is about 31% of the total governorate population. The existing wastewater treatment plant had a design capacity to serve 26,000 residents of Tafilah city and Eis. This means that the existing treatment plant had no excess treatment capacity for additional people.

Tafilah governorate was considered in the USAID funded Water and Wastewater Infrastructure Project (WIP) that was implemented by CDM-Smith. The project submitted a master plan report for the governorate which investigated current sewer systems and needs for sewer systems upgrade and expansion to 2035. The master plan did not cover the unsewered locality of Hasa.

Five new localities were identified in this report as a service priority considering the number of population to be served; Busira, Gharandal, Qadesyeh, AlAin Al bayda', and Hasa. Covering these localities, in addition to expansion of the existing Tafilah system to cover areas within Tafilah Qasabah, Busira, and Hasa districts will increase the service coverage in the governorate to reach 82% of the total population.

Based on the projected population of 95,786 by year 2015, and 120,557 by year 2025, and 151,733 by year 2035, following wastewater systems and treatment needs and costs are estimated:

	Immediate (to 2015)	Year 2025	Year 2035
Needs	<ol style="list-style-type: none"> <li>No immediate wastewater systems are envisioned. Funds for Tafilah WWTP immediate expansion has been committed by WAJ for tendering procedure.</li> <li>Replacement of Interceptors is recommended for 2015 due to increased population in the service area which require about 17 Km of sewer networks</li> <li>Replacement of existing pipes</li> </ol>	<ol style="list-style-type: none"> <li>wastewater collection system which will be serving unserved population within Tafilah city, Ies, Ruwaym and Al Ain Al Bayda'a</li> <li>Additional wastewater collection system and Tafilah WWTP expansion which will be serving unserved population within Tafilah city, Ies, Ruwaym and Al Ain Al Bayda'a in the catchment area.</li> </ol>	<ol style="list-style-type: none"> <li>Additional wastewater collection system and Tafilah WWTP expansion which will be serving unserved population within Tafilah city, Ies, Ruwaym and Al Ain Al Bayda'a in the catchment area.</li> <li>Additional Wastewater collection system (55km) serving Busayra/ Gharandal localities</li> <li>Additional wastewater collection system (40 km) serving Qadesicyah locality.</li> <li>Additional wastewater collection system (35 km) serving Hasa locality.</li> </ol>
Estimated Costs	<ol style="list-style-type: none"> <li>0 million JD</li> <li>3.3 million JD</li> <li>2.0 million JD</li> </ol>	<ol style="list-style-type: none"> <li>20.05 million JD</li> </ol>	<ol style="list-style-type: none"> <li>7.8 million JD</li> <li>13 million JD</li> <li>8.3 million JD</li> <li>9.3 million JD</li> </ol>

The cost to cover the expansion of the WWTP and network expansion for year 2015, and 2025, and 2035 are estimated as shown in the summary table below.

Governorate Total (MJOD)			
Priority	2012-2015	2016-2025	2026-2035
Capital Costs	5.3	20.05	38.4
Yearly Expansion programs	0.3yearly		

Other small localities will need to continue the current practice of discharging domestic wastewater flows to the septic pits if there were no records for health or water pollution problems.

## Introduction

Tafilah Governorate lies 180 km southwest of Amman in the southern part of Jordan with Karak Governorate to the north, Ma'an Governorate to the east and south, Aqaba Governorate to the southwest and the West Bank to the west. The economy relies upon the public sector, agriculture and tourism. The mountainous landscape and deep wadis descending toward the Dead Sea offer many scenic vistas. Tourists can also visit nature reserves and thermal springs. The total land area is 2,114 km<sup>2</sup>, or 2.5% of the land area of Jordan. The current population is 89,400, the lowest among the 12 Governorates of Jordan. Population density in Tafilah Governorate is approximately 42.3 person/km<sup>2</sup>. The Governorate contains 41 localities. The population is estimated to grow to 151,733 in 2035.

Tafilah City is the most populous locality, with 27,924 residents. The majority of the population (95%) is located to the northwestern and southern part of the governorate on about 30% of the governorate area, with the remaining population distributed in the east and west of the governorate.

Tafilah governorate has 41 localities distributed over 3 districts:

- Tafilah Qasabah district
- Busira district
- Hasa district

Figure 14-1 shows the population distribution on the locality level.

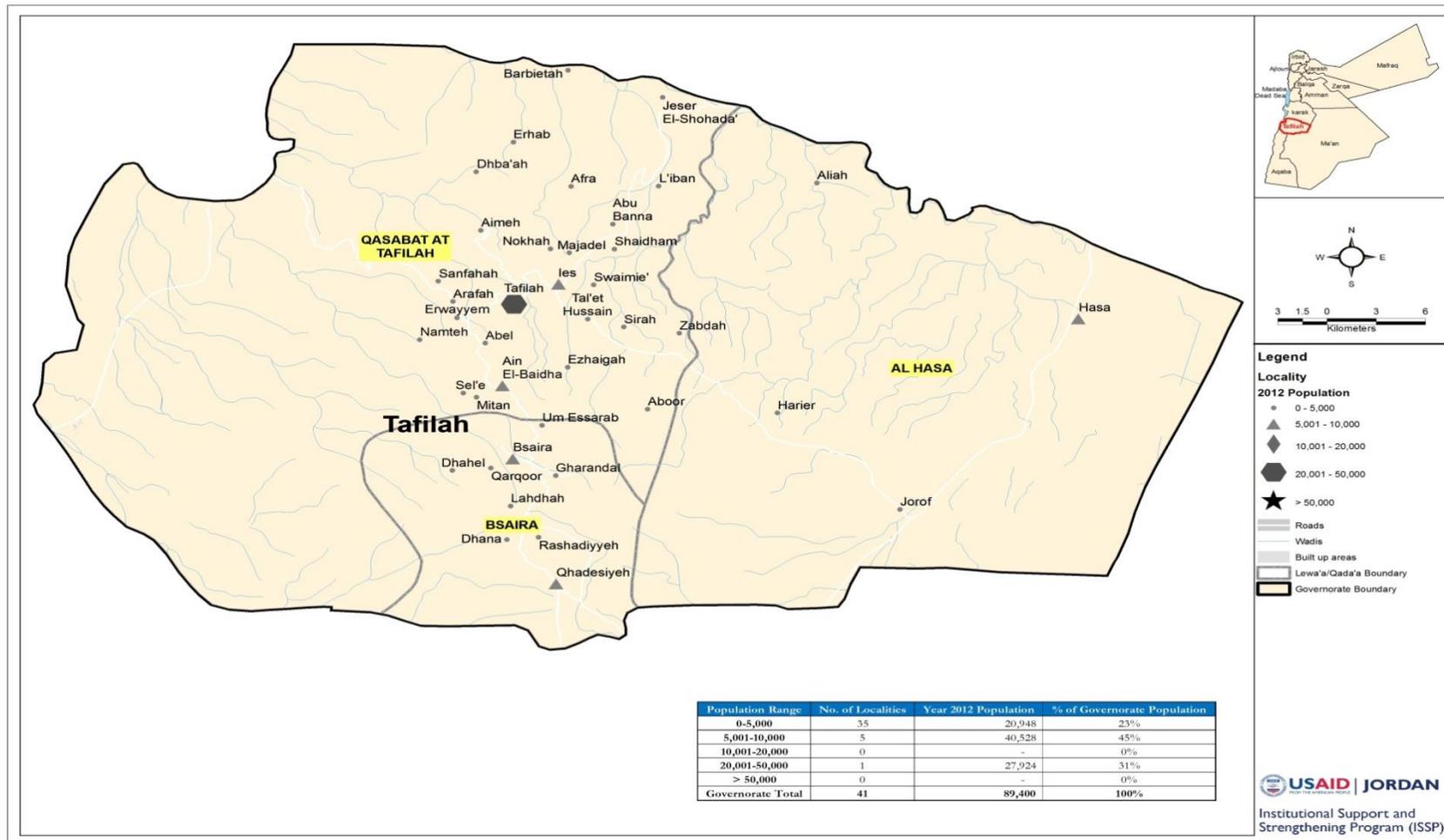


Figure 14-1: Tafilah Governorate Districts and Localities

## **Wastewater Service Area:**

The existing sewer service areas cover localities within Tafilah Qasabah sub-districts providing coverage to approximately 31% of the total governorate population. The sewer systems in the governorate are served through one WWTP: Tafilah WWTP. This plant was constructed in 1988 with a 1,600 m<sup>3</sup>/day design capacity and serves 90% of Tafilah City's 25,000 residents and 46% of the 2,300 residents of Eis. The existing Tafilah wastewater service area encompasses Tafilah City, Eis, and a portion of Ruwaym. The Tafilah WWTP receives flow from the East and West interceptors, each 300 mm in diameter.

- The East Interceptor takes flow from four pumping stations in Eis and Mansura, and by gravity from the Tafilah city center area; the East Interceptor serves a 251 hectare catchment with a population of 13,500. The East Interceptor currently has low slopes.
- The West interceptor receives flow from a portion of Ruwaym and the west side of Tafilah; it serves a 172 hectare catchment with a population of 13,800. The total catchment area is 423 hectares, with a served population of 27,300 via 3,000 customer connections.

There are four pump stations Eis 1, Eis 2, Mansura 1 and Mansura 2. Eis 1 and Eis 2 were constructed to serve different parts of Eis village; Mansura 1 and Mansura 2 serve the majority of the Mansura area. Mansura 1 discharges to Mansura 2 via a 150 mm diameter force main and a 300 mm diameter gravity line. Flow from Mansura 2 discharges to a 250 mm diameter pressure main, and then by a 300 mm diameter gravity line to the East Interceptor.

### **Tafilah city Service Area**

Tafilah City, is the biggest locality within the governorate and is part of Tafilah Qasabah sub-district. It has a population of 27,924 (31% of the governorate population). Tafilah city service area encompasses parts of Les locality east of Tafilah city and Ruwaym southeast of Tafilah city serving approximately 27,000 people.

The sewer system flows into two 300mm interceptors - East and West. The East interceptor receives flow by gravity from the Tafilah city center area, while the west interceptor receives flow from the west side of Tafilah. The slopes for the interceptors are low. Both interceptors flow to Tafilah WWTP. Figure 14-2 shows Tafilah governorate wastewater existing system.

## **Wastewater Treatment:**

**Tafilah WWTP:** The Tafilah WWTP was constructed in 1988, and was a trickling filter WWTP with a 1,600 m<sup>3</sup>/day design capacity. The plant was capable of designed to handle an organic concentration of 1,680 kg/d. The plant currently receives about an average flow of about 1,575 m<sup>3</sup>/day, which is about 98 % of the design hydraulic load. In terms of biological load, the plant receives an average BOD load of 991 kg/d which is about 59% of the BOD design load. An assessment for the WWTP processes operation was conducted. Recommended improvements were set for each process operation. Funds for Tafilah WWTP immediate expansion have been committed by WAJ for tendering. The expansion should raise the design flow capacity to 7,500 m<sup>3</sup>/day and the design BOD load to 5,400 kg/day.

The unserved population of Tafilah city is about 3000 persons, with additional 1,300 persons in Rwaym, and 1,050 in Les (Rwaym is already served locality with population less than 5,000). These lie within the WWTP service area. The 300mm East and 300mm West Interceptors currently have low slopes, therefore replacement of both Interceptors is recommended for 2015 due to the increased population in the service area which would require about 17 km of sewer networks at an estimated cost of 3.315 MJOD.

The locality of Al Ain Al Bayda' which lies to the south of Tafilah city and has a population of 9845 can be served with wastewater flows directed to the Tafilah WWTP.

Figure 14-2 shows existing wastewater system in Tafilah governorate.

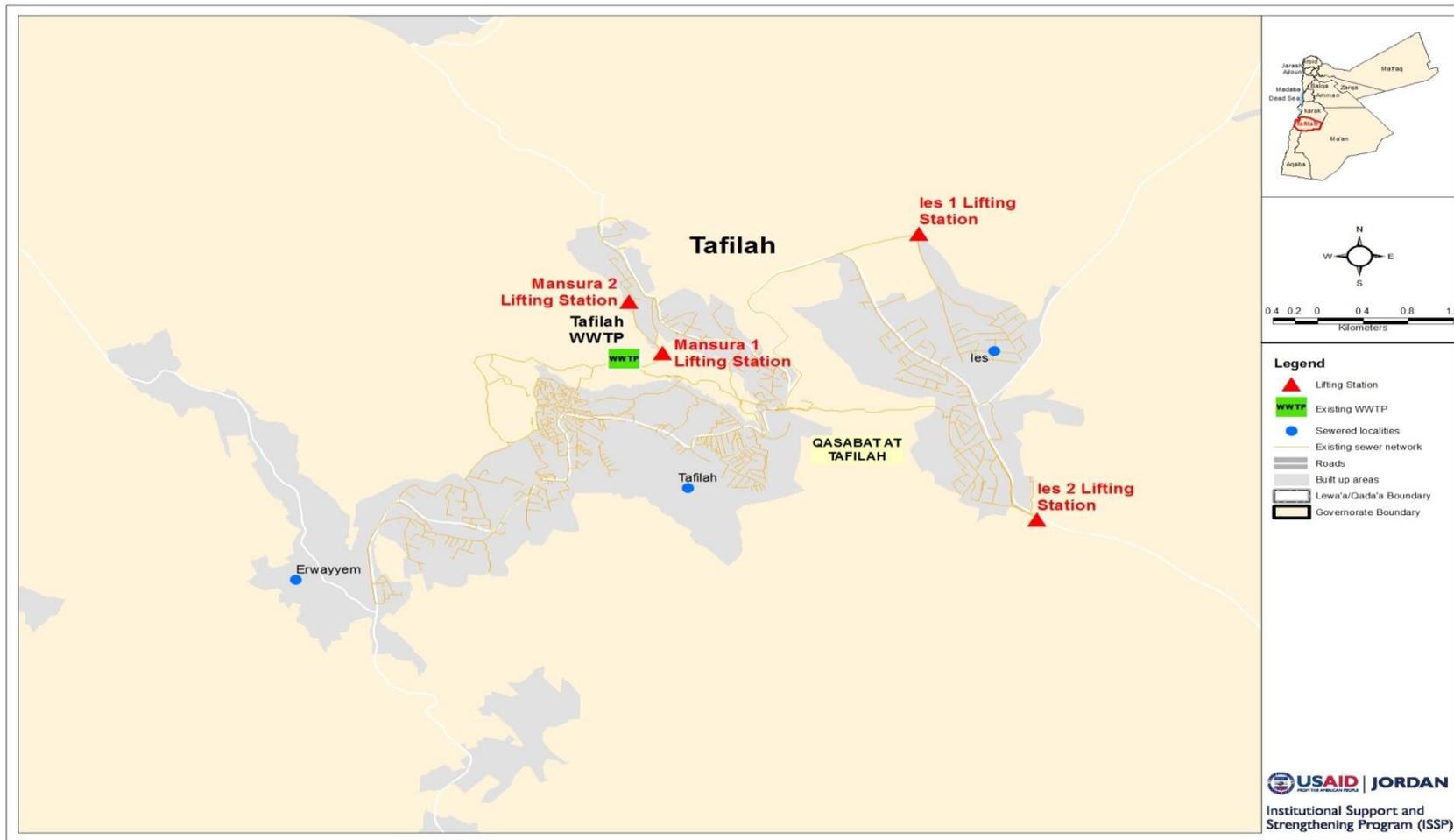


Figure 14-2: Existing Wastewater systems in Tafilah governorate

## Unsewered Areas:

Areas that are not covered with sewer systems are served through septic pits that are likely not sealed. The population that is not covered with sewer systems is approximately 61,700 or 69% of the total population. Approximately 25,000 people (45% of the unsewered areas) are located within Tafilah Qasabah sub-district with the remaining population distributed over small localities throughout the governorate in both Busira and Hasa sub-districts. The largest localities which have populations of more than 5,000 residents are Busira, Garandal, Qahdisyeh, and Hasa collectively contributing to 45% of the governorate population.

Other localities will continue to use septic pits as there is no history for water pollution or any health problems.

**Table 14-1: Unsewered localities with more than 5,000 population in Tafileh**

District	Locality	Current unsewered Population (2012)	% of Governorate Population
Tafilah Qasabah	Tafilah city	5,350	6%
Tafilah Qasabah	AlAin al Bayda'	9845	11%
Hasa	Hasa	9264	10.4%
Busira	Busira	8170	9.1%
	Gharandel	4743	5.3%
	Qahdisyeh	8237	9.2%

Figure 14-3 shows proposed wastewater systems in Tafilah governorate

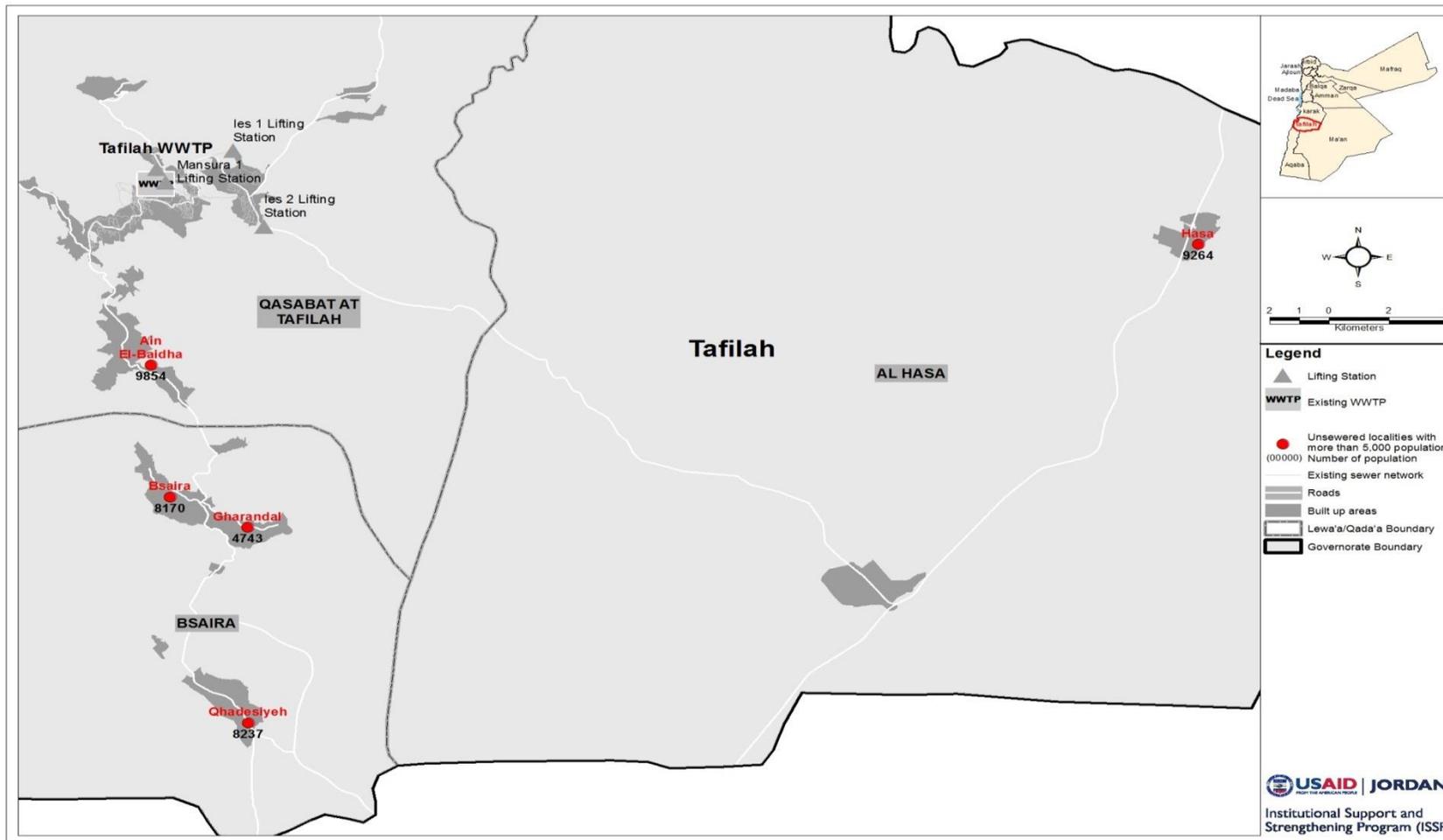


Figure 3:

Figure 14-3: Proposed wastewater systems for unserved localities in Tafilah governorate

## Projected Wastewater Loads

Table 14-2 below shows the population projections for each of the currently served population and unsewered areas. The population projection figures used are based on the WIP numbers that were used to estimate water and wastewater loads.

**Table 14-2: Population Projections in Tafilah**

Service System	WWTP	Status	Served Population (2012)	Projected Population		
				2015	2025	2035
Tafilah city service area	Tafilah WWTP	Existing	27,000	37,493	47,189	59,391
Tafilah service area (Al Ain Al Bayda')	Tafilah WWTP	Proposed network		10,558	13,288	16,725
Busira&Garandal	Busira & Garandal WWTP	Proposed WWTP & network		13,836	17,413	21,916
Hasa	Hasa WWTP	Proposed WWTP & network		9,926	12,493	15,723
Qadesieyeh	Qadesieyeh WWTP	Proposed WWTP & network		8,825	11,108	13,980
Unsewered Localities below 5,000 population	-	-		15,297	19,252	24,231

The above population figures were used to develop the wastewater flows and biological loads projections shown in the Table 14-3 below.

**Table 14-3: Wastewater flows and biological loads projections**

Service Area	2015	2025	2035
<b>Projected Wastewater Flow (m<sup>3</sup>/day)</b>			
Tafilah city service area	3,000	3,775	4,750
(Al Ain Al Bayda')	845	1,063	1,338
Busira&Garandal	1,107	1,393	1,753
Hasa	794	1,000	1,258
Qadesieyeh	706	889	1,120
Unsewered Localities below 5,000 population	1,224	1,540	1,938
<b>Projected Wastewater Load (kg/day)</b>			
Tafilah city service area	2,437	3,067	3,860
(Al Ain Al Bayda')	686	864	1,087
Busira&Garandal	899	1,132	1,425
Hasa	645	812	1,022
Qadesieyeh	574	722	909
Unsewered Localities below 5,000 population	612	770	969

Table 14-3 shows that the Tafilah WWTP need to have flow design capacity of 3,000 m<sup>3</sup>/day and BOD load design of about 2500 kg/day by year 2015.

## **Identification of Wastewater Service Needs Through 2035**

### **Tafilah Wastewater System**

The current service coverage within the city of Tafilah is 90%. Al-Ies and parts of Rwaym are also served within the Tafilah WWTP service area. The WWTP is currently receiving almost the complete design capacity flow and about 60% of BOD design load. Therefore WAJ has already committed funds for expansion and upgrading of the existing plant. The replacement of East and West interceptors are recommended for 2015 due to their low slopes and in view of increased population for years 2015, 2025, and 2035.

Projected population, flow capacities, and BOD loads for Tafilah city and Al Ain Al Bayda'a for the years 2015, 2025, 2035 require considerations for wastewater network expansions. This can be staged these respective years.

### **Tafilah Wastewater System 2015:**

With existing design capacity of Tafilah WWTP of 1,600 m<sup>3</sup>/ day, it is envisaged that the WWTP needs to be expanded by 2,300 m<sup>3</sup>/day as a first expansion Stage 1. Funds for this expansion have already been committed by WAJ for further tendering.

The treatment plant capacity will be capable of handling Tafilah service area population projection until year 2035. Therefore there is no further expansion for the WWTP envisaged.

### **Tafilah Wastewater System 2025:**

Projected population for 'Tafilah city, Al-Ies, Rwaym , and Al Ain Al Bayda' of 48,051 for 2015 will result a wastewater flow of 3,845 m<sup>3</sup>/day and BOD load of 3,123 kg/d. Additionally sewer networks will need further expansion. The estimated length of the sewer system including the house connections is estimated to be 52.5 km using 2.5 m network /person. The estimated cost is about (8.9+1.6) 10.5million JD. The replacement of both Interceptors is recommended for 2015 due to increased population in the service area which require about 17 Km of sewer networks with estimated cost of 3.3million JD.

Also, projected population for 'Tafilah city, Al-Ies, Rwaym, and Al Ain Al Bayda' of 60,477 in 2025 will result a wastewater flow of 4,838 m<sup>3</sup>/day and BOD load of 3,921kg/d. Sewer networks will need further extension. The estimated length of the sewer system including the house connections is estimated to be 31.5 km using 2.5 m network/person. The estimated cost is about (5.3+0.95) 6.25million JD.

### **Tafilah Wastewater System 2035:**

Projected population for 'Tafilah city, Al-Ies, Rwaym , and Al Ain Al Bayda' of 76,116 in 2035 will result in a wastewater flow of 6,088m<sup>3</sup>/day and BOD load of 4947kg/d. The sewer networks will need further extension. The estimated length of the sewer system including the house connections is estimated to be 39 km using 2.5 m network/person. Estimated cost is about (6.6+1.2) 7.8million JD.

### **Busira & Garandal**

Busira and Gharandal lie adjacent to each other about 15 km to the south of Tafilah city. Their topography allows a gravity sewer system that could feed a suitable WWTP site. Projected population for both localities of 21,916 in 2035 will result in a wastewater flow of 1,753 m<sup>3</sup>/day and BOD load of 1,425kg/d. The estimated length of the sewer system including the house connections is estimated to be 55 km using 2.5 m network/person. The estimated cost is approximately (9.4+1.7) 11.1million JD and WWTP costs 1.9million JD.

### **Hasa**

Hasa locality is a town remote from the others. A projected population of 15,723 in 2035 will result in wastewater flows of 1258 m<sup>3</sup>/day and BOD load of 1022 kg/d. The estimated length of the sewer system including the house connections is estimated to be 39.3 km using 2.5 m network/person to be served by a new WWTP. The estimated cost is about (6.7+1.2) 7.9million JD and WWTP costs are 1.4million JD.

### **Qadesieyeh**

Qadesieyeh is located about 30km south of Tafilah city and close to Maa'an governorate. The projected population of 13,980 in 2035 will result in wastewater flows of 1,120 m<sup>3</sup>/day and BOD load of 909 kg/d. It is envisioned that the locality will be served by a separate WWTP. The estimated length of the sewer system including the house connections is estimated to be 35 km using 2.5 m network /person. The estimated cost is about (6+1.1) 7.1million JD and WWTP costs are 1.2million JD.

Figure 14-4 shows proposed system priorities for years 2015, 2025, and 2035.

### **Investment Cost and Priorities**

Table 14-4 below shows the estimated investment cost for Tafilah governorate.

**Table 14-4: Estimated investment cost for Tafilah governorate**

Service System	Item	Investment Cost (Million JD)		
		2012-2015 (Immediate)	2016-2025	2026-2035
Tafilah	Tafilah system (trunk, collection sewer, house connection)	-	20.05	7.8
	Replacement of existing pipes	2.0		
Busayra/ Gharandal	Busayra/Gharandal new WWTP, and system (trunk, collection sewer, house connection)	-	-	13.0
Qadesieyah	New WWTP and collection system	-	-	8.3
Hasa	New WWTP and collection system	-	-	9.3
Tafilah, Ies, & Ruwaym	Annual program for collection sewers and house connection expansion (1000 people/yr @ 303JD/capita)	0.3yearly (2010-2035)		
<b>Governorate Total</b>				
Capital Costs		2.0	20.05	38.4
Yearly Expansion programs		0.3yearly		

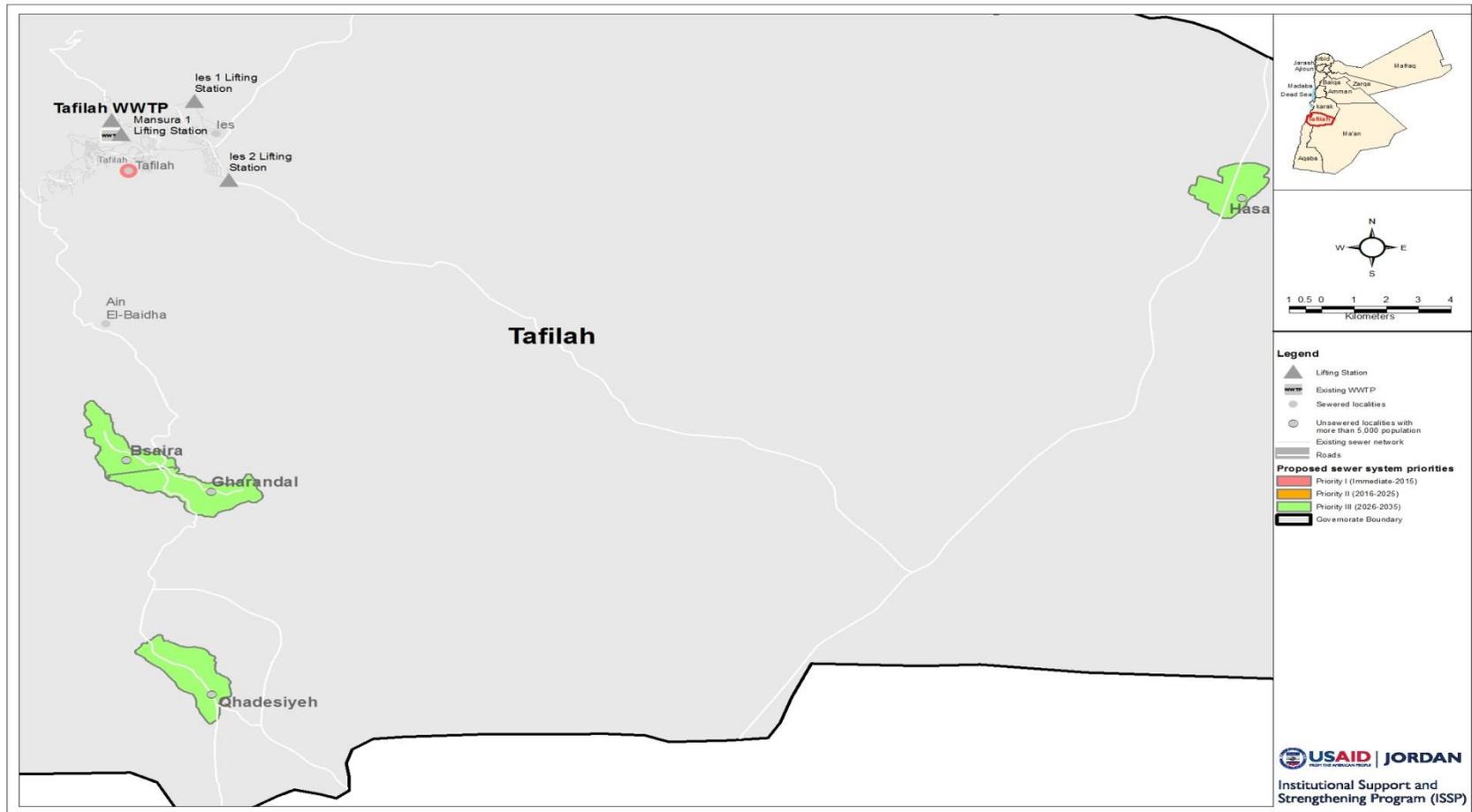


Figure 14-4: Proposed system priorities for Tafilah Governorate

# 15 MA'AN

## Summary of Wastewater Assessment

Ma'an Governorate has a current population of 121,400 (2012) which is projected to grow to 201,531 in 2035, an increase of 66% over the next 23 years. The population is distributed over 71 localities of which 5 have a population of greater than 5,000 with a combined population of 72,700 (60% of the governorate population). The remaining 66 localities have populations less than 5,000 with a total of 48,700 (40% of the governorate population). Currently, 6 localities are served by wastewater collection systems while the remaining 65 are served by septic pits.

Within the seweried localities collectively only 46,820 people are connected to the sewer system which represents 39% of the total governorate population. There are 2 existing wastewater treatment plants with total design capacity to serve 104,000 people and 2 septage wastewater treatment plants in Shobak and Mansoura with a total design capacity to serve 14,300 people indicating that an additional 71,480 people can be served at the existing plants.

Based on the projected population of 161,600 by year 2025 and 201,400 by year 2035, the following wastewater systems and treatment are needed:

	Immediate (to 2015)	Year 2025	Year 2035
Needs	Upgrading parts within existing sewer system	<ol style="list-style-type: none"> <li>1. Additional wastewater collection and treatment systems for 32,300 people</li> <li>2. Septage wastewater treatment for 44,800 people</li> </ol>	<ol style="list-style-type: none"> <li>1. Additional (between 2025-2035) wastewater collection and treatment systems for 50,114 people</li> <li>2. Septage wastewater treatment for 5,300 people (for localities of population less than 5,000)</li> </ol>
Estimated Costs	0.1 million JDs	<ol style="list-style-type: none"> <li>1. 11.5 million JDs</li> <li>2. 4.7 million JDs</li> </ol>	<ol style="list-style-type: none"> <li>1. 10.5 million JDs</li> <li>2. 0.6 million JDs</li> </ol>

Details of the analysis of existing situation with respect to wastewater collection and treatment and needed improvements for the future (up to 2035), along with associated investment costs are presented in the following sections.

## Introduction

Ma'an governorate is located in the southern part of Jordan and has the largest area of the 12 governorates national wide. However it has the lowest population density of about 3.7 persons/km<sup>2</sup> with a total current population of 121,400 which is estimated to grow to 201,531 by 2035.

Two natural units characterize the topography of the governorate. These include the desert which covers about 95% of the governorate area, and a mountainous area named Al Sharah Mountains located in the western part of the governorate.

The majority of the population (93%) is located in the western part of the governorate on about 6% of the governorate area; the remaining 7% of the population are distributed in the middle and southern part of the governorate within Al Jafer Sub-District.

Ma'an governorate has 71 localities distributed in 4 districts:

- Ma'an Qasabah: contains 5 sub districts (Ma'an, Iel, Jafr, Mraighah, Athroh)
- Petra district
- Shobak district
- Huseiniya district

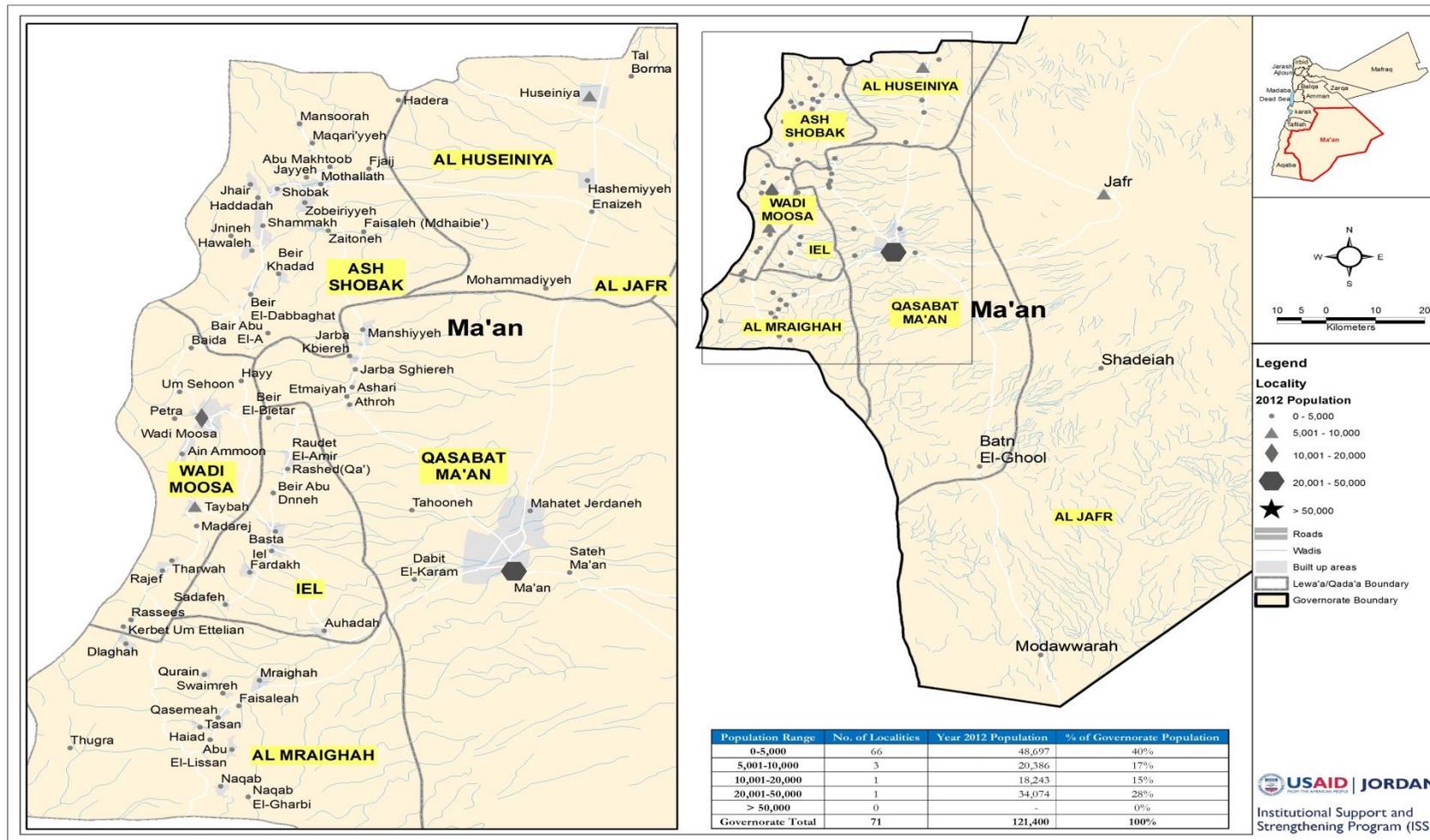


Figure 15-1: Ma'an Governorate Districts and Localities

## Wastewater Service Areas:

The existing sewer service areas only cover localities within two sub-districts only: Ma'an and Petra with a combined service coverage of about 39% of the total governorate population. The sewer systems in the governorate are served through two WWTPs; Ma'an WWTP and Wadi Mousa WWTP.

**Ma'an Service Area:** Ma'an City is the biggest locality within the governorate and is part of Ma'an sub-district. It has a population of 34,074 (28% of the governorate population). About 24,500 are served through the sewer system connected to Ma'an WWTP. The system is divided into two major systems: One system flows directly to the WWTP through a 500mm pipe; the second system flows to a lifting station that is located to the Northwest of the WWTP and transfers the wastewater through a pressure main 250mm in diameter.

**Wadi Mousa Service Area:** The Second service area is served by Wadi Mousa WWTP. Localities served are Wadi Mousa, Taybah, Um Sehoon, Baida and Ain Ammoon. Total population connected to the system is approximately 22,317. The system transfers wastewater from localities through a major interceptor that extends from Taybah to the WWTP. The diameter of the interceptor ranges between 250 mm at Taybah and ends with 500mm diameter before the treatment plant. The system has 4 lifting stations: Taybah, Wadi Mousa, Bdoul and Baida, which pump wastewater from localities to the major interceptor.

## Wastewater Treatment

**Ma'an WWTP:** The plant was constructed in 1989 to provide wastewater treatment through stabilization ponds which were replaced in 2008 by extended aeration with an average design capacity of 3,900m<sup>3</sup>/d and a BOD design load of 4,040kg/d. The plant received an average flow of about 2,360m<sup>3</sup>/d in 2012, representing about 40% of the design hydraulic load. Biologically, the plant received an average BOD load of 922kg/d in the same year (about 56% of the BOD design load). The plant is designed to serve a population of 62,100.

**Wadi Mousa WWTP:** The plant was constructed in 2003 using the extended aeration process with a hydraulic design capacity of 3,400m<sup>3</sup>/d and a BOD load of 2,720kg/d. The plant currently serves about 22,317 of the population of Petra Sub-district and receives 2,536m<sup>3</sup>/d. Current BOD Load is about 40% of the design BOD with an average of 786kg/d. The plant is designed to serve a population of 45,300.

**Shobak WWTP:**The plant was constructed in 2010 as a natural treatment plant that receives wastewater loads from Tankers only. The plant serves Shobak and adjacent villages and has design capacities of 350m<sup>3</sup>/d for the hydraulic load and a BOD of 648kg/d for the biological load. Current hydraulic and biological loads are about 19% of the design capacity. The plant is designed to serve a population of 14,400.

**Mansoura WWTP:** The plant was constructed in 2010 as a natural treatment plant that receives wastewater loads from Tankers only. The plant serves Mansoura village and has design capacities of 50m<sup>3</sup>/d and receives 13m<sup>3</sup>/d.

Existing Wastewater systems in Ma'an Governorate are shown in Figure 15-2

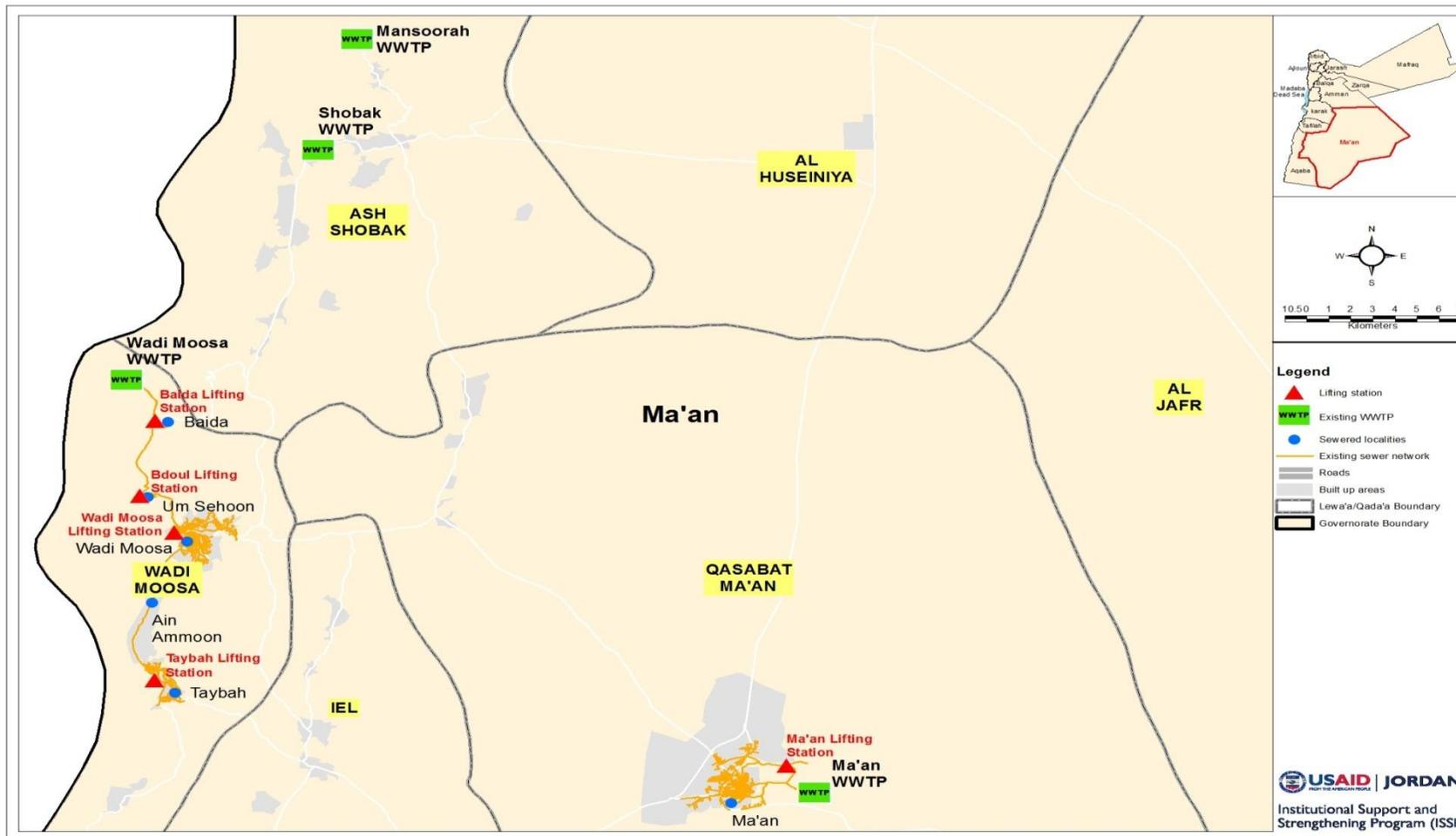


Figure 15-2: Existing Wastewater systems in Ma'an governorate

## Unsewered Areas:

Areas that are not connected to sewer systems are served through septic holes that are probably not sealed. The population that is not serviced by sewer systems is about 74,580, which is about 61% of the total population. About 14,000 (19% of the unsewered areas) are located within Ma'an and Wadi Mousa systems. The remaining population is distributed at small localities all over the governorate. The biggest two localities which have population of more than 5,000 contain 23% of the governorate population; Huseiniya and Jafr. It is proposed to service these areas.

Other localities will continue to use septic pits as there is no history for water pollution or any health problems.

District / Sub district	Current unsewered Population (2012)	% of Governorate Population
Ma'an Qasabah / Jafr	6,743	6%
Huseiniya	7,536	6%

Unsewered Localities in Ma'an Governorate are shown in Figure 15-3

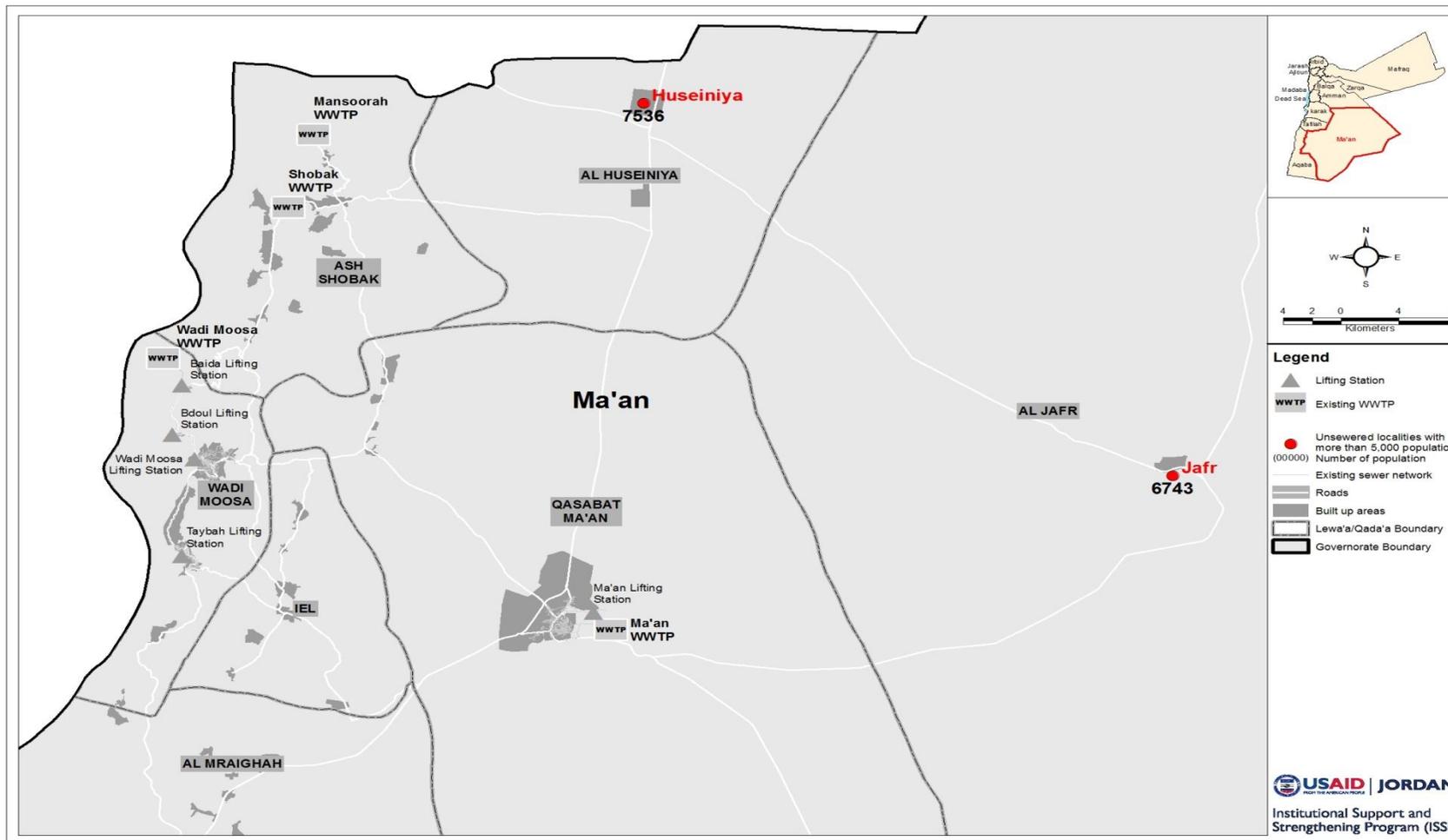


Figure 15-3: Unsewered localities in Ma'an Governorate

## Projected Wastewater Loads

Table 15-1 below shows the population projections for both the current served population and the unsewered areas. Population projection figures used for Ma'an and Wadi Mousa are based on the WIP numbers that were used to estimate water and wastewater loads.

**Table 15-1: WWTP status and Population Projections for Ma'an**

Service System	WWTP	Status	Served Population (2012)	Projected Population				
				2015	2020	2025	2030	2035
Ma'an	Ma'an WWTP	Existing	24,500	40,682	47,852	55,609	63,873	72,832
Wadi Mousa	Wadi Mousa WWTP	Existing	22,317	31,300	36,547	42,209	48,230	54,745
Huseiniya	-	Proposed	-	8,050	8,986	10,032	11,198	12,501
Jafr	-	Proposed	-	7,203	8,041	8,976	10,020	11,185
Unsewered Localities below 5,000 population	-	-	-	42,449	43,340	44,777	47,076	50,114

The above population figures were used to develop the wastewater flows and biological loads projections shown in Table 15-2.

The table shows that the Ma'an WWTP will reach the wastewater flow design capacity in 2020. Projected BOD load will also exceed the design capacity in 2030 by about 3%. As for Wadi Mousa WWTP, the plant will reach its design capacity for wastewater flows and BOD load in 2025.

**Table 15-2: Wastewater flows and biological loads projections**

Service Area	2015	2020	2025	2030	2035
<i>Projected Wastewater Volume (m<sup>3</sup>/d)</i>					
Ma'an	3,255	3,828	4,449	5,110	5,827
Wadi Mousa	2,504	2,924	3,377	3,858	4,380
Huseiniya	644	719	803	896	1,000
Jafer	576	643	718	802	895
Unsewered Localities below 5,000 population	3,396	3,467	3,582	3,766	4,009
<i>Projected Wastewater Load BOD (kg/d)</i>					
Ma'an	2,644	3,110	3,615	4,152	4,734
Wadi Mousa	2,035	2,376	2,744	3,135	3,558
Huseiniya	523	584	652	728	813
Jafr	468	523	583	651	727
Unsewered Localities below 5,000 population	2,759	2,817	2,911	3,060	3,257

## Identification of Wastewater Service Needs Through 2035

### Ma'an City

The current service coverage within the city is 74% with a population of approximately 9,574 not served yet located within the Ma'an WWTP service area. In the USAID funded Water and Waste Water Infrastructure Project, it was stated that the Ma'an sewer system serves 'a good fraction' of the existing population. It was assumed that half of the population growth will take place on developed land, which can be served by the existing collection sewers and sewer service connections. This reduces the cost per person served from 606JD/capita to 303JD/capita representing only the cost of network connections.

Certain improvements were also identified in the WIP. The immediate priority was to rehabilitate the Ma'an P.S. The study listed four locations where the trunk sewers need to be upsized in 2015 and 2025. In 2015, upsizing a section in the system from 300 to 400mm is needed. Other sewers to be upsized will be needed by 2025. A new pump will need to be added with a new pressure main in 2025.

Ma'an WWTP current capacity is sufficient to treat 3,900m<sup>3</sup>/d and will exceed this capacity in 2020. However, tanks and other civil works are designed to accommodate 5,772m<sup>3</sup>/d which is near the year 2035 projected load (5,827m<sup>3</sup>/d).

### **Wadi Mousa**

Priorities identified in the WIP are summarized in the table below. In WIP, it was stated that the Wadi Mousa sewer system serves a good fraction of the existing population. Similar to Maan, it was assumed that half of the population growth will take place on developed land, which can be served by the existing collection sewers and sewer service connections. Again, this reduces the cost per person served from 606JD/capita to 303JD/capita.

WIP indicated that the sewer and pump station have sufficient capacity to accommodate wastewater loads up to 2035. Wadi Mousa WWTP capacity is 3,400m<sup>3</sup>/d. This will be exceeded by the year 2025, according to the WIP wastewater forecast (at 100% served). It is assumed that a third module of the plant will be completed by 2025, to raise the total capacity to 5,100m<sup>3</sup>/d. This capacity will be able to serve the population through year 2050.

### **Jafer**

Jafer is located about 60km from Ma'an city with a population of 6,743. Projected population is 11,185 in 2035 which will result in a projected wastewater flow of about 900m<sup>3</sup>/d. The estimated length of the sewer system including the house connections is 20.2km.

### **Huseiniya**

The third biggest community in the governorate is located about 45 km to the north of Ma'an city and has a current population of 7,536. Projected population of 12,501 in 2035 will result in a wastewater flow of 1,000m<sup>3</sup>/d. The estimated length of the sewer system including the house connections is estimated at 22.6 km.

Table 15-3 below shows unsewered localities (with population of more than 5,000) and their service needs.

**Table 15-3: Unsewered localities with more than 5,000 population in Ma'an**

District	Locality	Current Population	Projected Population (2035)	Collection Wastewater System estimated Length (km)	Wastewater Treatment Needed (m <sup>3</sup> /d)	Estimated Biological Loads (BOD, Kg/d)
Ma'an Qasabah	Jafr	6,743	11,185	20.2	900	440
Huseiniya	Huseiniya	7,536	12,501	22.6	1000	490

Table 15-4 below illustrates the estimated costs needed to implement required wastewater service needs to accommodate projected loads of the current systems and to expand the wastewater service area to cover localities with more than 5,000 population.

**Table 15-4: Cost Estimate for Wastewater Service Needs in Ma'an Governorate**

Service System	Item	Investment Cost (Million JD)				
		Immediate (up to 2015)	2020	2025	2030	2035
Ma'an	Ma'an P.S.	0.022				
	Upsizing Trunk Sewer	0.060				
	WWTP mechanical and electrical upgrade		1.62			
	Trunk Sewers Upgrade Ma'an P.S expansion Force Mains			1.58		
	Annual program for collection sewers and house connection expansion (2000 people/yr @ 303JD/capita)	0.61 yearly (2010-2035)				
Wadi Mousa	Rehabilitation of Taybah P.S., Wadi Mousa P.S., Bdoul P.S., Baida P.S.	0.025				
	WWTP Expansion			2.9		
	Annual program for collection sewers and house connection expansion (1100 people/yr @ 303JD/capita)	0.33 yearly (2010-2035)				
Huseiniya	Constriction of Sewer system				7.6	
	Wastewater Treatment Cost				2.3	
	Annual program for collection sewers and house connection expansion (500 people/yr @ 303JD/capita)	0.15 yearly (2015-2035)				
Jafer	Constriction of Sewer system		4.1			

Service System	Item	Investment Cost (Million JD)				
		Immediate (up to 2015)	2020	2025	2030	2035
	Wastewater Treatment Cost		1.2		0.5	
	Annual program for collection sewers and house connection expansion (400people/yr @ 303JD/capita)		0.12 yearly (2015-2035)			
<b>Governorate Total</b>						
	Capital Costs	0.1	7	4.5	10.5	-
	Yearly Expansion programs	JD 0.94 mi/year		JD 1.21mi /year		

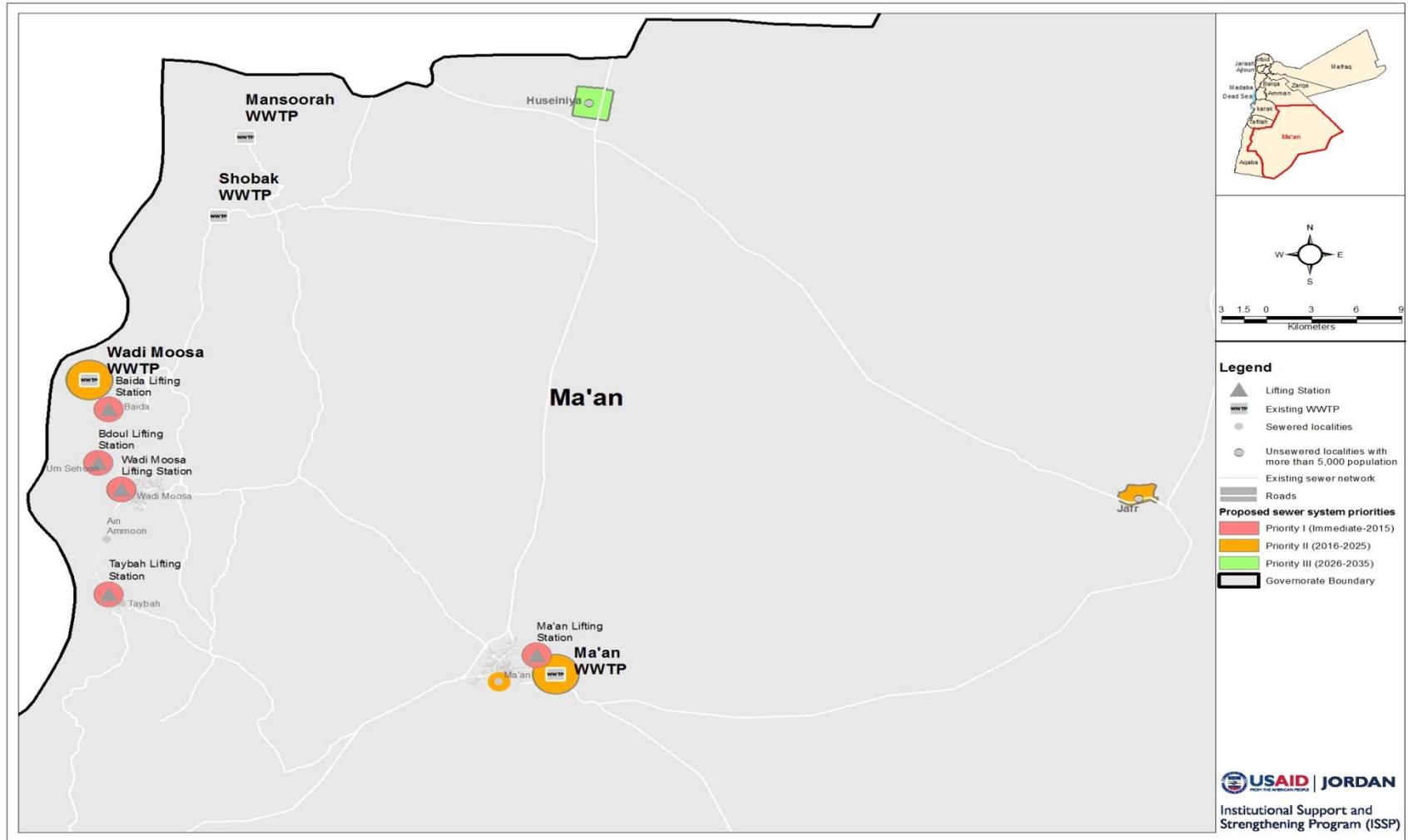


Figure 15-4: Investment Priorities in Ma'an Governorate

# 16 AQABA

## Summary of Wastewater Assessment

Aqaba is the southmost governorates located about 330 Km south of Amman city. Aqaba city is its major center. Aqaba is the fourth largest governorate in Jordan by area but ranked 10th by population. The DOS 2012 population of the governorate is 139,200 which are projected to grow to 253,745 in 2035, an increase of 82.3% over the next 23 years. The population is distributed over 29 localities of which only two have a population over 5,000 with a combined population of 119,210 (86% of the governorate population). The remaining 27 localities have populations less than 5,000 with a totaling of 20,000 (14% of the governorate population).

Currently, the population served with wastewater are only those in Aqaba Qasabah and within the existing wastewater collection system serving the City of Aqaba. The system currently receives flow from 92% of the ASEZA area serving 100,420 people (72% of total governorate population). This is done through a sewer network of 250km of gravity sewers and 7km of rising mains with six pumping stations currently in operation. Only small pockets of development are not connected to the main system. Flow from these areas either drain to small privately maintained treatment plants or to septic tanks. Flow from the septic tanks is discharged directly to the WWTP via tankers.

The Aqaba WWTP is located in the north west of the catchment and flows arrive at the inlet (head) works via a single 1200mm diameter gravity sewer. The WWTP contains both a mechanical and a natural treatment process with a capacity of 21,000m<sup>3</sup>/day.

Flows arrive at the inlet works before being split to either the mechanical or natural process plants. The works currently allow a maximum flow of 12,000m<sup>3</sup>/day through the mechanical process and 9,000m<sup>3</sup>/day through the natural process.

The treated sewage effluent being discharged from both processes of the WWTP is not currently allowed to be discharged to sea due to its potential impact on the coral reefs. Therefore it is used for irrigation and for Jordan Phosphate Mines (JPM) – Cooling Systems.

The mechanical process of the WWTP is currently designed to receive maximum flows through each part of the process of 24,000m<sup>3</sup>/day except for the Oxidation and Clarifiers processes which can only take 12,000 m<sup>3</sup>/day .

A master plan report done by Montgomery Watson in association with Arabtech Jardaneh was submitted for Aqaba city. The report investigated current sewer systems and the needs for sewer systems upgrade and expansion through to the year 2030. The master plan did not cover the unsewered localities distributed in the governorate districts.

ISSP planning for Aqaba governorate was for the horizon of year 2030 in compliance with Montgomery Watson master plan.

Quairah locality is the only unsewered locality in Aqaba governorate with more than 5,000 inhabitants. Quairah population of 10,060 resides within the vicinity of Disi water basin. This locality is discharging domestic wastewater flows to septic pits, which is then transferred to a septage collection plant run by the municipality of Quairah. Some tankers dispose their contents at Aqaba WWTP. There were no records for health or water pollution problems in that locality attributed to wastewater discharge; therefore the current practice is recommended to continue.

Expansion of the existing wastewater system to cover new developing areas and newly under construction projects (Aylah, Saraya, marsa Zayed, King Hussien International airport expansion ) within Aqaba WWTP service area will increase the service coverage in the governorate to reach 90 % of the total population.

Other small localities with a population less than 5,000 will need to continue the current practice of discharging domestic wastewater flows to the septic pits if there were no records for health or water pollution problems.

Aqaba wastewater network is in a good position to cope with the increased flows predicted to the year 2030. The existing sewer network has been designed well and able to cope with future flows. The most significant and costly item requiring expansion is the Aqaba WWTP and this makes up a large percentage of the investment plan for both 2020 and 2030.

Other significant items considered to meet the expansion needs of the next 20 years are:

1. Construction of a new PS and rising main to serve the airport.
2. Replacement of Main Pumping Station and associated rising main.
3. Construction of new sewers to serve the areas outlined for development on the outskirts of Aqaba that are currently uninhabited.

Cost to cover the expansion of the WWTP, network expansion, pump stations, and pressure mains for year 2020 and 2030, are estimated. Table 16-1 shows a summary of the estimated cost with the impact of new developments in Aqaba, while Table 16-2 shows a summary for the estimated cost without the impact of the new developments.

**Table 16-1: Summary of estimated cost with the impact of the new developments in Aqaba**

Item	Estimated Expansion Cost (JD)	
	2020	2030
Total Cost	72,725,789	67,725,398

**Table 16-2: Summary for the estimated cost without the impact of the new developments in Aqaba**

Item	Estimated Expansion Cost (JD)	
	2020	2030
Total Cost	46,479,171	55,158,477

## Introduction

Aqaba Governorate lies in the south western tip of Jordan. It borders Ma'an Governorate from the east, Tafilah Governorate from the north, Saudi Arabia from the south, the occupied territories from the west, and the Gulf of Aqaba from the southwest. Governorate area is 6904 km<sup>2</sup>, with a population density of 19.3 person/km<sup>2</sup>. Aqaba Governorate is divided into three districts: Aqaba Qasabah, Wadi Araba, and Quairah with 29 localities.

The City of Aqaba is situated at the head of the Gulf of Aqaba, 330km south of Amman. Aqaba is Jordan's only seaport and its 27km coastline, abundant with Coral Reefs, makes it one of Jordan's

foremost tourist attractions. Aqaba also contains an International Airport, which is located to the north, giving it unparalleled transport links to the Middle East, Africa and Europe.

There are two international crossing points in Aqaba Governorate, the Durra Border Crossing and Wadi Araba crossing. Aqaba city has the only Jordanian port at the Red Sea. It plays an important role in the economic life of Jordan. The port is Jordan's most important import/export hub. The industrial port lies about 15 km to the south from the beaches and the Aqaba city center. Two of Jordan's top three tourist destinations are in the Aqaba Governorate, namely Wadi Rum, and the port city of Aqaba.

Aqaba is also located within the Aqaba Special Economic Zone (ASEZA), which was introduced in 2001. The ASEZA was setup by the government of Jordan as a liberalised, low taxed, duty-free and multi sector development zone setup principally to encourage multiple investment opportunities. The formation of ASEZA area has assisted in producing the high levels of growth now being seen in Aqaba.

The majority of the population (79%) is residing mainly in Aqaba city and 1% in nearby localities, with the remaining population distributed in Quairah district east of Aqaba Qasabah with population of 17%, and Wadi Araba district north of Aqaba Qasabah with 3% of the governorate population.

There is a number of large residential developments planned for Aqaba, all of which will need to be connected to the sewer network. In addition there are also a number of large hotels planned, which will significantly increase the amount of tourist opportunities and bring further stress to the sewer network.

The most significant developments planned for Aqaba are as follows:

**Saraya:** Development is located on the coast line between the main town and the Royal Palace, It will contain a combination of residential, hotel and commercial properties. Once completed and fully occupied the total wastewater flow generated from Saraya is anticipated to be approximately 3,560 m<sup>3</sup>/day.

**Ayla:** Ayla is located on the west side of Saraya. The development will contain a range of facilities including hotels and residential communities. Once completed and fully occupied the total wastewater flow generated from Ayla is anticipated to be approximately 12,750 m<sup>3</sup>/day.

**Marsa Zayed:** Marsa Zayed is the largest of the major new developments planned for Aqaba. It is located south of the main town centre and will be constructed on the land currently occupied by the port. The development will contain a range of facilities including hotels, offices, recreational areas, commercial areas and residential properties.

Once completed and fully occupied the total wastewater flow generated from Marsa Zayed is anticipated to be approximately 15,050 m<sup>3</sup>/day.

**King Hussein International Airport:** There is currently a plan to undertake a major expansion of King Hussien International Airport. The airport currently serves approximately 240,000 passengers travelling through it each year and it is not connected to the existing sewer system. In the future passenger numbers are expected to increase to 1.8 million per year and the airport will be connected to the main sewer network.

**Northern Industrial Area:** It is planned to significantly expand the industrial area located to the north of Aqaba. Currently there is no detailed information available for the expansion. However, an area of land has been assigned for industrial development and this has been used as the basis for future flow calculations.

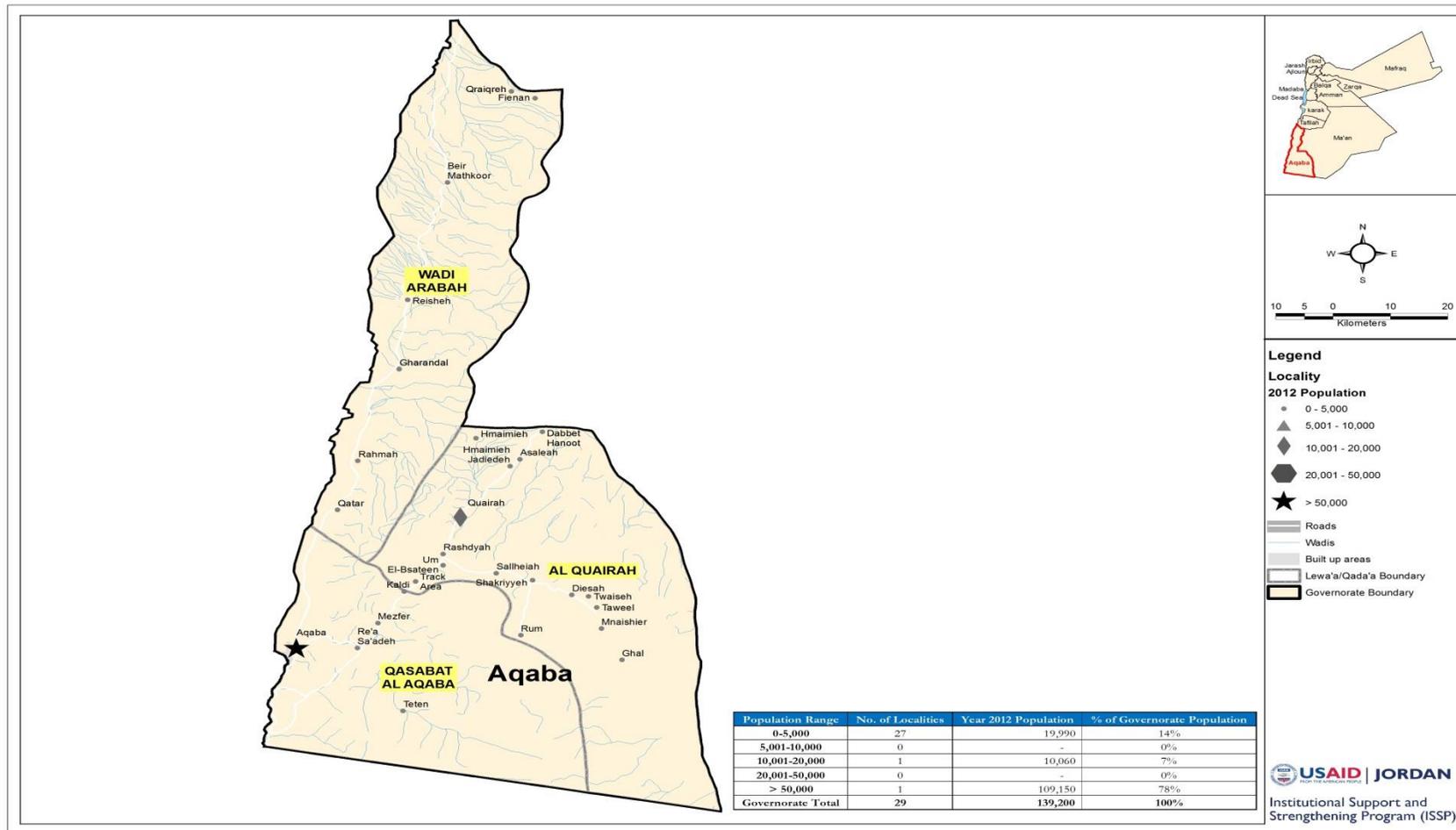


Figure 16-1: Aqaba Governorate Districts and Localities

## **Wastewater Service Area:**

The only existing sewer service area in the governorate serving Aqaba city is within the Aqabah Qasabah district. The total served population in the service area is 100,420 representing service coverage of about 72% of the total governorate population. The sewer system in Aqaba is connected to the only WWTP located northwest of the center of Aqaba city. Figure 16-2 shows the catchment area.

The existing wastewater collection system was put into operation in 1987. It is a combined system of gravity sewers and pumped force mains along with a stabilization ponds and disinfection facilities. In the year 2000, a comprehensive study to upgrade the system was carried out. Improvements were introduced to the system such as construction of new gravity sewers to serve the unconnected residents, improvements of the existing pump stations, and most importantly upgrading and expansion of Aqaba wastewater treatment plant.

Aqaba existing sewer network consists of 250km of gravity sewers and 7km of rising mains. Pipe diameters within the system range from 200mm to 1200mm. There are a total of six pumping stations currently in operation in the system, which are:

- Main pumping station
- Mina pumping station (PS2)
- Hayfayer No.1 pumping station
- Hayfayer No.2 pumping station
- Hayfayer No.3 pumping station
- Royal Palace pumping station

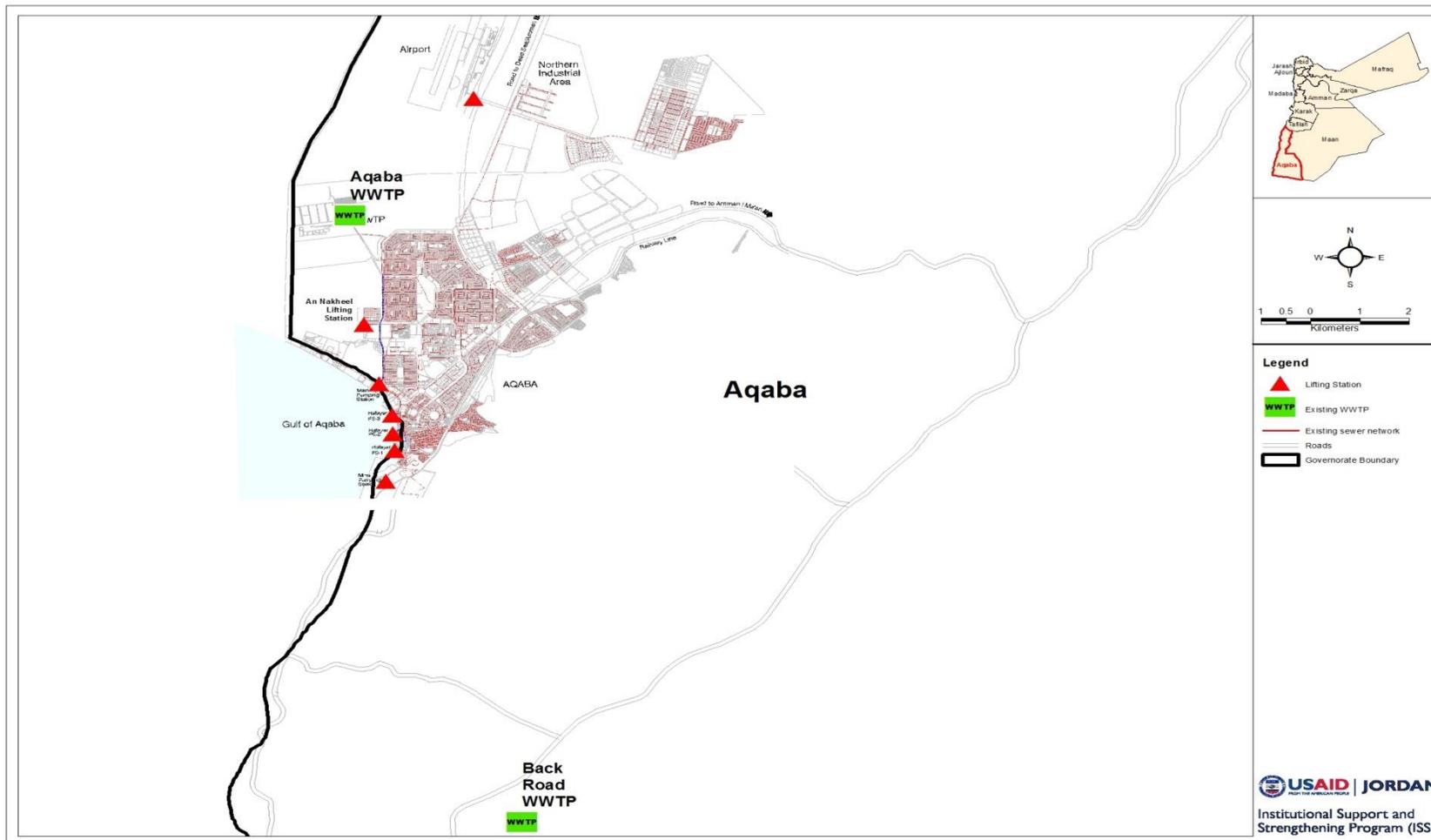


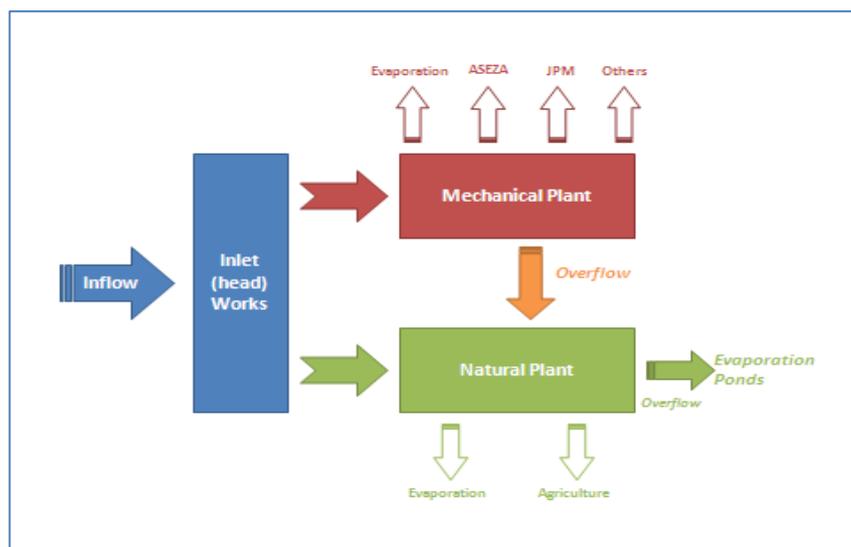
Figure 16-2: Aqaba WWTP catchment area

## Wastewater Treatment:

The Aqaba WWTP is located in the north west of the catchment and flows arrive to a single 1200mm diameter gravity sewer. The WWTP contains both mechanical and natural treatment processes providing a capacity of 21,000m<sup>3</sup>/day and a design BOD load of 13,100 kg/day. Figure below shows the schematic of the treatment process.

The works currently allow a maximum flow of 12,000m<sup>3</sup>/day and a design BOD of 5,000 kg/day through the mechanical process and 9,000m<sup>3</sup>/day and design BOD of 8,100kg/day through the natural process. According to WAJ information, the current flow through the mechanical process is 8,500 m<sup>3</sup>/day and the current BOD load is 3,000 kg/day, and through the natural process are 7,220 m<sup>3</sup>/day and the current BOD load is 2,614 kg/day. It is proposed to upgrade the mechanical WWTP from 12,000 m<sup>3</sup>/day to 26,165 m<sup>3</sup>/day by year 2020 with a flow design load of 24,000 m<sup>3</sup>/day, and BOD design load of 10,600 kg/day. This will be done using the same process that is currently in place and therefore it is simply a case of installing additional units for each stage of the treatment process to meet the flow requirements. The flow predictions for 2030 of 52,640 m<sup>3</sup>/day suggest that the WWTP will need further expansion to enable it to cope with future flows. It is proposed that the expansion will continue based on a similar approach to that adopted for the 2020.

The treated sewage effluent being discharged from both processes of the WWTP is not currently allowed to be discharged to sea due to its potential impact on the coral reefs. There are a number of distribution points for treated water from both processes of the WWTP (Evaporation, ASEZA-irrigation, Jordan Phosphate Mines- cooling systems, and agriculture) as seen in the Figure below.



## Unsewered Areas:

The only locality that is not incorporated in the sewer system and having above 5,000 inhabitant is Quairah. It is served through septic pits that are likely not sealed. The population that is not covered with sewer systems in that locality represents 10,909 people which is approximately 7% of the total population. This is projected to grow to 14,290 in 2025 and to 18,720 in 2035. The Quairah locality is discharging domestic wastewater flows to septic pits, which are then transferred to a septage collection plant run by the municipality of Quairah. Some tankers dump their contents into the Aqaba WWTP. There are no records for health or water pollution problems in that locality due to wastewater discharge; therefore the current practice is to continue.

Other localities will continue to use septic pits as there is no history for water pollution or any health problems.

## Projected Wastewater Loads

For Aqaba, two scenarios were adopted for the analysis, one with impact of the major new development and the second without such impact.

Table 16-3 below shows the population projections for the current served population and unsewered areas. The population projection figures used for Aqaba are based on the Aqaba Master Plan numbers that were used to estimate wastewater flows and loads.

**Table 16-3 Population Projections in Aqaba**

Service System	WWTP	Status	Served Population (2012)	Projected Population		
				2015	2020	2030
Aqaba	Aqaba WWTP	Existing	100,418	124,033	153,094	233,239

Table 16-4 below shows the projected wastewater flows with the impact of the new developments.

**Table 16-4: Wastewater flows and biological loads projections with new developments**

Service Area	2010	2020	2030
	Projected Wastewater Flow (m <sup>3</sup> /d)		
Aqaba	21,000	61,992	84,970
	Projected Wastewater Load (kg/d)		
Aqaba	10,625	31,368	42,995

**Table 16-5: Wastewater flows and biological loads projections without new developments**

Service Area	2010	2020	2030
	Projected Wastewater Flow (m <sup>3</sup> /d)		
Aqaba	21,000	38,165	52,640
	Projected Wastewater Load (kg/d)		
Aqaba	10,625	19,311	26,636

## Identification of Wastewater Service Needs Through 2030

### Aqaba City

#### Year 2020:

The main sewer network will cope with the increased flows without any major problems except for the 300mm sewer line along Al Kornash street.

Trunk and main sewers shall be sized to cope with future flows.

The existing WWTP will become overloaded by 2020 and this is mostly due to the completion of some of the significant developments such as Ayla and Marsa Zayed.

Flows predicted to arrive at the WWTP at 2020 are in the order of 62,000 m<sup>3</sup>/day. This exceeds the maximum capacity of the plant and therefore plans should be made to either increase the capacity or replace the plant with a new larger WWTP. In addition, considerations must be given to the WWTP current capabilities. The plant currently can only cope with a maximum flow of 21,000m<sup>3</sup>/day. As a matter of priority, plans must be made to expanding the existing plant to enable it to cope with the new flows as they increase over the short to medium future terms.

**Year 2035:**

The main sewer network will be able to cope with the predicted increased flows.

The 200mm diameter sewer, which runs down Al Farouq Street, serves the Al Remal area requires upgrading to meet the demands of the 2030 flow predictions.

Improvements to the wastewater pump stations.

Flows to the WWTP will increase further in 2030 to 84,970 m<sup>3</sup>/day and thus it becomes even more important that the options for expansion or replacement are considered.

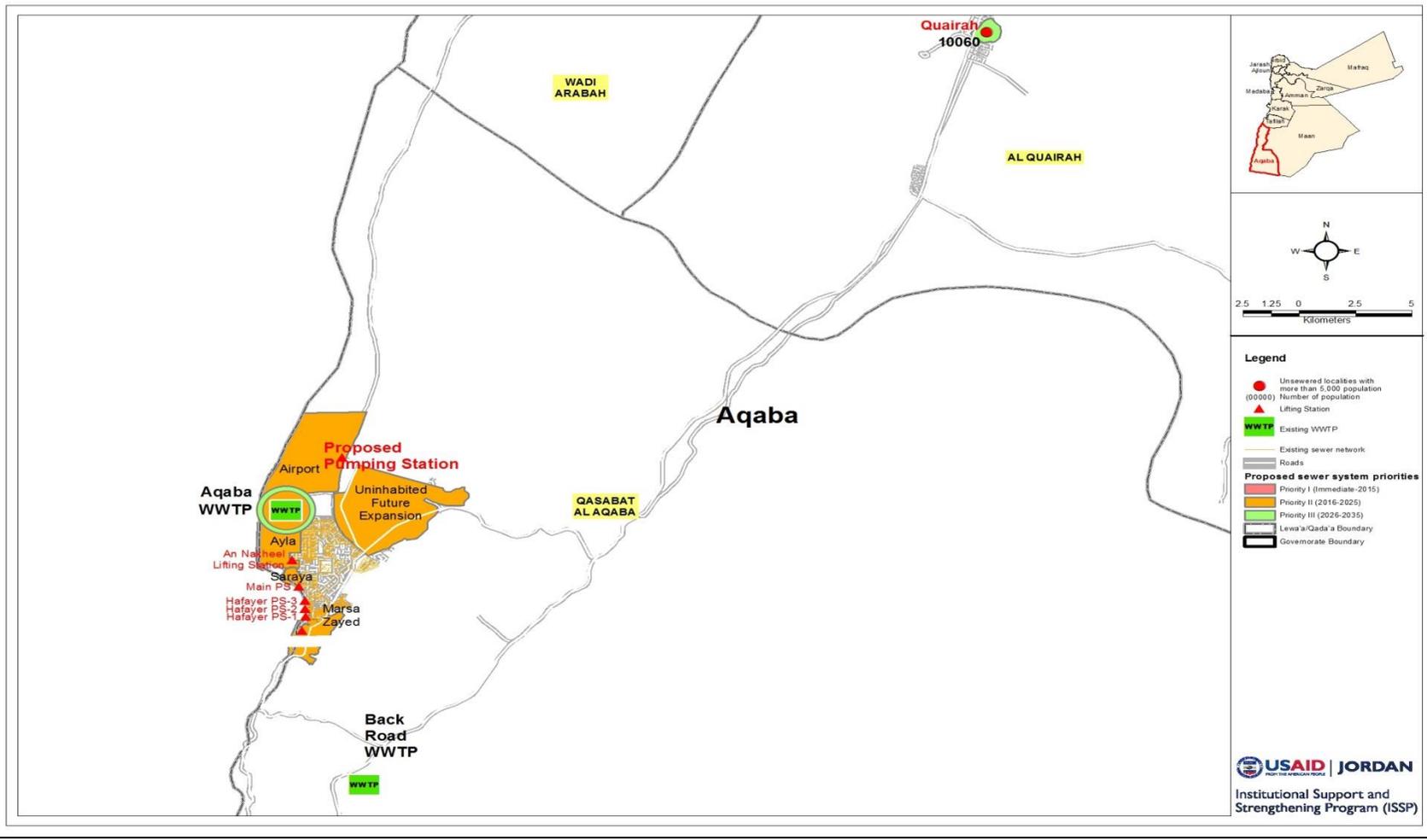


Figure 16-3: Investment Priorities in Aqaba Governorate

### **Estimation of Expansion Costs**

Two scenarios were adopted for the analysis of the investment strategy, one taking into account the impact of the major new development and the second without such impact.

#### **1. Estimated Cost with the impact of new developments**

The estimated cost with the impact of new developments is shown in the Table 16-6 below for the planning year 2020, and 2030. Total estimated cost for year 2020 is 72.7 MJOD, and for year 2030 is 67.7 MJOD. These estimated costs were divided into two phases for year 2020, and also for two phases for year 2030.

**Table 16-6: Total Estimated Cost with the impact of new developments**

Item	Estimated Expansion Cost (JD)	
	2020	2030
Construction of new trunk and minor sewers	12,450,711	17,914,240
Construction of new rising mains	120,000	1,425,000
Construction of new pumping stations	110,000	7,607,000
Expansion of existing WWTP	43,185,281	25,150,220
Other Costs – preliminaries & engineering	5,686,599	5,209,646
Contingency (20%)	11,173,198	10,419,292
<b>TOTAL COST</b>	<b>72,725,789</b>	<b>67,725,398</b>

Investment strategy for year 2020 is divided into two phases, phase 1 between 2011 and 2015, and phase 2 between 2016 and 2020 for planning purposes. Based on this the estimated capital investment costs for year 2020 phased in two intervals, are shown in the Table 16-7 below.

Table 16-7: Estimated capital investment costs for year 2020 phased in two intervals

Description	Estimated Cost million (million JD)
<b>Phase I (2011 to 2016)</b>	
Expansion of collection networks	3.11
Expansion of WWTP	43.18
<b>Subtotal Phase I</b>	<b>46.29</b>
<b>Phase II (2016 to 2020)</b>	
Reinforcement of collection networks	0.0156
Expansion of collection networks	9.33
Pumping stations and rising mains	0.23
<b>Subtotal Phase II</b>	<b>9.57</b>
<b>Total</b>	<b>55.86</b>
Preliminaries @ 2%	1.11
Engineering @ 8 %	4.46
Contingencies @ 20%	11.17
<b>Grand Total</b>	<b>72.60</b>

Also the estimated capital investment costs for year 2030 are phased in two intervals, 2021 to 2025 and 2026 to 2030 for investment planning. Based on this, the estimated capital investment costs for year 2030 phased in two intervals as shown in the Table 16-8 below.

Table 16-8: Estimated capital investment costs for year 2030 phased in two intervals

Description	Estimated Cost million (million JD)
<b>Phase I (2021 to 2025)</b>	
Expansion of collection networks	4.47
Expansion of WwTP	25.15
<b>Subtotal Phase I</b>	<b>29.62</b>
<b>Phase II (2026 to 2030)</b>	
Reinforcement of collection networks	0.021
Expansion of collection networks	13.42
Pumping stations and rising mains	9.03
Expansion of WWTP	
<b>Subtotal Phase II</b>	<b>22.47</b>
<b>Total</b>	<b>52.09</b>
Preliminaries @ 2%	1.04

Description	Estimated Cost million (million JD)
Engineering @ 8 %	4.16
Contingencies @ 20%	10.41
<i>Grand Total</i>	67.70

## 2. Estimated Cost without the impact of new developments

The estimated cost without the impact of new developments is shown in the Table 16-9 below for the planning year 2020, and 2030. Total estimated cost for year 2020 is 46.5 MJOD, and for year 2030 is 55.2 MJOD. These estimated costs were divided into two phases for year 2020, and also for two phases for year 2030.

**Table 16-9: Total Estimated Cost without the impact of new developments**

Item	Estimated Expansion Cost (JD)	
	2020	2030
Construction of new trunk and minor sewers	12,435,111	17,914,240
Construction of new rising mains	120,000	1,425,000
Construction of new pumping stations	110,000	7,607,000
Expansion of existing WWTP	23,088,098	15,483,358
Other Costs – preliminaries & engineering	3,575,320	4,242,959
Contingency (20%)	7,150,642	8,485,920
TOTAL COST	46,479,171	55,158,477

Investment strategy for year 2020 is divided into two phases, phase 1 between 2011 and 2015, and phase 2 between 2016 and 2020 for investment planning. Based on this, the estimated capital investment costs for year 2020 phased in two intervals as shown in Table 16-10 below.

**Table 16-10: Estimated capital investment costs for year 2020 phased in two intervals**

Description	Estimated Cost million (million JD)
<b>Phase I (2011 to 2016)</b>	
Expansion of collection networks	3.11
Expansion of WwTP	23.08
<b>Subtotal Phase I</b>	<b>26.19</b>
<b>Phase II (2016 to 2020)</b>	
Reinforcement of collection networks	Nil
Expansion of collection networks	9.33
Pumping stations and rising mains	0.23
<b>Subtotal Phase II</b>	<b>9.56</b>
<b>Total</b>	<b>35.75</b>
Preliminaries @ 2%	0.72
Engineering @ 8 %	2.86
Contingencies @ 20%	7.15
<b>Grand Total</b>	<b>46.48</b>

Also the estimated capital investment costs for year 2030 phased in two intervals, 2021 to 2025 and 2026 to 2030 for investment planning. Based on this the estimated capital investment costs for year 2030 phased in two intervals as shown in the Table 16-11 below.

**Table 16-11: Estimated capital investment costs for year 2030 phased in two intervals**

Description	Estimated Cost million (million JD)
<b>Phase I (2021 to 2025)</b>	
Expansion of collection networks	4.47
Expansion of WWTP	15.48
<b>Subtotal Phase I</b>	<b>19.96</b>
<b>Phase II (2026 to 2030)</b>	
Reinforcement of collection networks	0.021
Expansion of collection networks	13.42
Pumping stations and rising mains	9.03
Expansion of WwTP	
<b>Subtotal Phase II</b>	<b>22.47</b>
<b>Total</b>	<b>42.43</b>
Preliminaries @ 2%	0.84

Description	Estimated Cost million (million JD)
Engineering @ 8 %	3.40
Contingencies @ 20%	8.48
Grand Total	55.15

# ANNEXES

# ANNEX I - POPULATION PROJECTIONS

## DOS: Population Projection for Governorates

Year	Population (Jordan)	Amman	Balqa	Madaba	Zarqa	Irbid	Mafraq	Jerash	Ajloun	Karak	Tafilah	Ma'an	Aqaba
2012	6,388,000	2,473,400	428,000	159,700	951,800	1,137,100	300,300	191,700	146,900	249,100	89,400	121,400	139,200
2015	6,971,656	2,683,493	469,181	172,849	1,044,018	1,243,822	329,301	214,926	161,899	272,344	99,208	134,577	153,146
2020	7,737,109	2,964,056	522,542	192,007	1,161,904	1,385,475	368,995	245,289	182,145	301,475	112,363	151,938	174,647
2025	8,456,140	3,219,559	573,720	210,162	1,275,549	1,519,625	408,825	276,267	202,332	327,924	125,569	168,984	198,615
2030	9,134,464	3,455,528	623,065	227,291	1,387,291	1,645,187	448,045	306,892	221,883	352,519	138,398	185,474	225,057
2035	9,767,149	3,681,579	671,101	243,363	1,497,119	1,764,207	485,343	336,976	240,403	376,250	150,708	201,531	253,745
% increase of 23 Yrs	52.90	48.90	56.70	52.30	57.30	55.10	61.60	75.70	63.60	51.00	78.50	66.00	82.20
Avg. Growth rate of 23 Yrs	1.90	1.70	2.00	1.80	2.00	2.00	2.10	2.45	2.15	1.80	2.30	2.20	2.70

### Amman Governorate

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
Amman Qasabah	Amman	Alabdaly	116,078	122,152	132,988	144,787	157,632	171,617
		Ras Alain	116,716	122,823	133,719	145,583	158,498	172,560
		Almadina	37,943	39,928	43,471	47,327	51,526	56,097
		Zahran	67,608	71,145	77,457	84,329	91,810	99,956
		Alyarmok	191,940	201,983	219,902	239,411	260,651	283,775
		Bader	173,385	182,457	198,644	216,267	235,454	256,343
			<b>703,670</b>	<b>740,488</b>	<b>806,182</b>	<b>877,704</b>	<b>955,571</b>	<b>1,040,347</b>
Marka	Marka	Tareq	64,601	67,981	74,012	80,578	87,727	95,510
		Marka	113,628	119,573	130,182	141,731	154,305	167,994
		Alnaser	171,779	180,767	196,804	214,264	233,273	253,968
		Basman	266,182	280,109	304,960	332,015	361,470	393,539
			<b>616,190</b>	<b>648,431</b>	<b>705,958</b>	<b>768,588</b>	<b>836,775</b>	<b>911,011</b>
Alquaismeh	Alquaismeh	Alquaismeh,Aljwaydeh,A bu Alanda,Alrajeeb	172,570	181,599	197,710	215,251	234,347	255,138
		Khraibet Essooq,Jawa,Yadoodeh	108,222	113,884	123,988	134,988	146,964	160,002
		Um Qsair,Moqabaleen	46,848	49,299	53,673	58,435	63,619	69,263
			<b>327,640</b>	<b>344,783</b>	<b>375,371</b>	<b>408,673</b>	<b>444,929</b>	<b>484,402</b>
Al-Jani'ah	Al-Jani'ah	Jbaiha	81,765	86,043	93,677	101,987	111,035	120,886
		Swailah	78,898	83,026	90,392	98411	107142	116,647
		Tla'a Alali,Khelda,Um Essommaq	144,167	151,710	165,170	179823	195776	213,145
		Eskan Abu Nsair	31,432	33,077	36,011	39206	42684	46,471
		Shafa Badran	19,528	20,550	22,373	24358	26519	28,871
			<b>355,790</b>	<b>374,406</b>	<b>407,622</b>	<b>443785</b>	<b>483157</b>	<b>526,021</b>
Wadi Essier	Wadi Essier	Wadi Essier	155,421	163,553	178,063	193860	211059	229,784

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
		Badr Jadeda	12,798	13,468	14,662	15,963	17,379	18,921
		Marj Elhamam	38,428	40,439	44,026	47,932	52,185	56,814
		Bassa	4,987	5,248	5,714	6,220	6,772	7,373
		Eraq Elamir	2,500	2,631	2,864	3,118	3,395	3,696
		Abu Essoos	358	377	410	447	486	529
		Bahath	93	98	107	116	126	137
		Almaniyyeh,Qhasabat	1,634	1,719	1,872	2,038	2,219	2,416
		Rajaha	718	756	823	896	975	1,062
		Thograh	39	41	45	49	53	58
		Hamdeih	327	344	375	408	444	483
		Wadi Eshta	203	214	233	253	276	300
		Tabaqa	415	437	475	518	564	614
		Dabbeh	432	455	495	539	587	639
		Um Njasa	271	285	310	338	368	401
		Fahs	132	139	151	165	179	195
		N'air	809	851	927	1009	1,099	1,196
		Dair	1,775	1,868	2,034	2,214	2,410	2,624
			<b>221,340</b>	<b>232,921</b>	<b>253,585</b>	<b>276,083</b>	<b>300,576</b>	<b>327,242</b>
Sahab	Sahab	Sahab	55,920	58,846	64,067	69,750	75,938	82,675
		Abdaliyyeh	8,324	8,760	9,537	10,383	11,304	12,307
		Zamlet Olia	87	92	100	109	118	129
		Khashafiyet Shamalyyeh	5,415	5,698	6,204	6,754	7,353	8,006
		Khashafiyet Janubyeh	912	960	1,045	1,138	1,238	1,348
		Manakher	555	584	636	692	754	821
		Ka'afour	33	35	38	41	45	49
		Baidha	1,158	1,219	1,327	1,444	1,573	1,712
		Rmedan	8	8	9	10	11	12

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
		Madhouna	228	240	261	284	310	337
			<b>72,640</b>	<b>76,441</b>	<b>83,222</b>	<b>90,606</b>	<b>98,644</b>	<b>107,395</b>
Jizeh	Jizeh	Jizeh	4,729	4,976	5,418	5,899	6,422	6,992
		Um Elamad	1,311	1,380	1,502	1,635	1,780	1,938
		Netel	960	1,010	1,100	1,197	1,304	1,419
		Libban	3,418	3,597	3,916	4,263	4,642	5,053
		Qastal	3,393	3,571	3,887	4,232	4,608	5,016
		Manja	837	881	959	1,044	1,137	1,237
		Um Elwalied	1,803	1,897	2,066	2,249	2,448	2,666
		Howwarah	504	530	577	629	684	745
		Arainbeh Gharbiyyeh	1,484	1,562	1,700	1,851	2,015	2,194
		Jloul	744	783	852	928	1,010	1,100
		Tnaib	206	217	236	257	280	305
		Manarah	322	339	369	402	437	476
		Khadra	504	530	577	629	684	745
		Zaitoonch	539	567	618	672	732	797
		Arainbeh Sharqiyyeh	974	1,025	1,116	1,215	1,323	1,440
		Za'faran	871	917	998	1,086	1,183	1,288
		Soofa	330	347	378	412	448	488
		Zwezia	251	264	288	313	341	371
		Um Qsair	2,519	2,651	2,886	3,142	3,421	3,724
		Dab'ah	678	713	777	846	921	1,002
		Zainab	428	450	490	534	581	633
		Edlayla (Dalielet Mtairat)	678	713	777	846	921	1,002
		Um Rommaneh	1,029	1,083	1,179	1,283	1,397	1,521
		Qnaitreh	653	687	748	815	887	965
Naseriyyeh	470	495	538	586	638	695		

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
		Zmaileh	2,082	2,191	2,385	2,597	2,827	3,078
		Sh'hba (Zabayer Wtairi)	134	141	154	167	182	198
		Kaldeh	154	162	176	192	209	228
		Khrayyem	32	34	37	40	43	47
		Mshatta	346	364	396	432	470	512
		Gbeih	46	48	53	57	62	68
		Saifeih (Zabayer Knayan)	140	147	160	175	190	207
		Baseleih	602	633	690	751	818	890
Jizeh	Jizeh	Thamad	103	108	118	128	140	152
		Salahia (Zabayer Twal)	699	736	801	872	949	1,033
		Mukhayyam Talbiyyeh	8,090	8,513	9,269	10,091	10,986	11,961
		Badou Wasat	605	637	693	755	822	894
		Kan El-Zabib	298	314	341	372	405	441
		Khannan (Ndwah)	144	152	165	180	196	213
		Tharah	11	12	13	14	15	16
		Qanater	178	187	204	222	242	263
		Hammam El-Tallaq	557	586	638	695	756	824
		Hammam El-Shmoot	1,174	1,235	1,345	1,464	1,594	1,736
			<b>45,030</b>	<b>47,386</b>	<b>51,590</b>	<b>56,167</b>	<b>61,150</b>	<b>66,575</b>
Jizeh	Um Rsas	Um Rsas	454	478	520	566	617	671
		Ramah	1,408	1,482	1,613	1,756	1,912	2,082
		Ramil	465	489	533	580	631	687
		Toar Hashash	501	527	574	625	680	741
		Salyeh	638	671	731	796	866	943
		Swaqah	289	304	331	360	392	427
		Damki	1,040	1,094	1,192	1,297	1,412	1,538
		Yahoon	284	299	325	354	386	420

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
		Elayyan	313	329	359	390	425	463
		Rojom Aeqab	162	170	186	202	220	240
		Jmayal	600	631	687	748	815	887
		Thrayya	51	54	58	64	69	75
		Mshairfah	919	967	1053	1146	1248	1359
		Rojom Fhaid	208	219	238	259	282	308
		Abu Hlaileefah	427	449	489	533	580	631
		Msaitbah	721	759	826	899	979	1066
		Buhairat (Mansheat El-suareah)	50	53	57	62	68	74
			<b>8,530</b>	<b>8,976</b>	<b>9,773</b>	<b>10,640</b>	<b>11,584</b>	<b>12,611</b>
		Mowaqqar	4,302	4,527	4,929	5,366	5,842	6,360
		Naqera	1,829	1,925	2,095	2,281	2,484	2,704
		Feisaliyyeh	6,035	6,351	6,914	7,528	8,195	8,922
		Maghayer Mhanna	1,794	1,888	2,055	2,238	2,436	2,652
		Dhaibeh Sharqiyyeh	2,837	2,985	3,250	3,539	3,853	4,194
		Manshiyyeh	1,900	1,999	2,177	2,370	2,580	2,809
		Um Botmah	2,355	2,478	2,698	2,937	3,198	3,482
		Hatmeia	1,032	1,086	1,182	1,287	1,401	1,526
		Ghazaleh	190	200	218	237	258	281
		Raudet Hussen Namuthajeh	5	5	6	6	7	7
		Hunaifiyyeh	276	290	316	344	375	408
		Falej (Rabyyeh)	51	54	58	64	69	75
		Zmailat	788	829	903	983	1,070	1,165
		Matabah (Mastabah)	25	26	29	31	34	37
		Jnab	411	433	471	513	558	608
			<b>23,830</b>	<b>25,077</b>	<b>27,302</b>	<b>29,724</b>	<b>32,361</b>	<b>35,232</b>
Mowaqqar	Rojom Shami	Rojom Shami Gharbi	5,156	5,426	5,907	6,431	7,002	7,623

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
		Salem	2,848	2,997	3,263	3,552	3,868	4,211
		Hashimeyyah	586	617	671	731	796	866
		Rojom Shami Sharqi	1,224	1,288	1,402	1,527	1,662	1,810
		Dhaibeh Gharbiyyeh	3,578	3,765	4,099	4,463	4,859	5,290
		Laseen	416	438	477	519	565	615
		Majedeah (Zabarah)	102	107	117	127	139	151
		Ktafeh	490	516	561	611	665	724
			<b>14,400</b>	<b>15,153</b>	<b>16,498</b>	<b>17,961</b>	<b>19,555</b>	<b>21,290</b>
		Na'oor	19,666	20,695	22,531	24,530	26,706	29,075
		Adasiyyeh	1,828	1,924	2,094	2,280	2,482	2,703
		Manshiyyeh,Um El-Qottain	2,249	2,367	2,577	2,805	3,054	3,325
		Torky	1,774	1,867	2,032	2,213	2,409	2,623
		Adbayan	1,465	1,542	1,678	1,827	1,989	2,166
		Mansoorah	2,030	2,136	2,326	2,532	2,757	3,001
		Binayat	7,936	8,351	9,092	9,899	10,777	11,733
		Um El-Sumaq	6,890	7,251	7,894	8,594	9,356	10,187
		Basset Na'oor	848	892	972	1,058	1,152	1,254
		Sail Hesban	1,425	1,500	1,633	1,777	1,935	2,107
		Amireah	1,028	1,082	1,178	1,282	1,396	1,520
		Bal'as	661	696	757	824	898	977
		Zbood	1,332	1,402	1,526	1,661	1,809	1,969
		Abu Naqlah	1,058	1,113	1,212	1,320	1,437	1,564
		Ajajreh	354	373	406	442	481	523
		Ewailiyyeh	476	501	545	594	646	704
			<b>51,020</b>	<b>53,690</b>	<b>58,453</b>	<b>63,638</b>	<b>69,284</b>	<b>75,431</b>
Na'oor	Um El-Basatien	Um El-Basatien	5,902	6,211	6,762	7,362	8,015	8,726
		Samek	3,256	3,426	3,730	4,061	4,422	4,814

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
		Um El-Asaker	830	873	951	1,035	1,127	1,227
		Um- El-Kindam	1,596	1,680	1,829	1,991	2,167	2,360
		Um-El-Berak	1,532	1,612	1,755	1,911	2,080	2,265
		MasooH	164	173	188	205	223	242
			<b>13,280</b>	<b>13,975</b>	<b>15,215</b>	<b>16,564</b>	<b>18,034</b>	<b>19,634</b>
Na'oor	Hesban	Hesban	3,261	3,432	3,736	4,068	4,428	4,821
		Rawdhah	6,493	6,833	7,439	8,099	8,817	9,600
		MshKar	3,657	3,848	4,190	4,561	4,966	5,407
		El-A'al	3,617	3,806	4,144	4,512	4,912	5,348
		Manshiyyet Hesban	1,573	1,655	1,802	1,962	2,136	2,326
		Karmet Hesban	1,439	1,514	1,649	1,795	1,954	2,128
			<b>20,040</b>	<b>21,089</b>	<b>22,959</b>	<b>24,996</b>	<b>27,214</b>	<b>29,628</b>
<b>Governorate Total</b>			<b>2,473,400</b>	<b>2,602,815</b>	<b>2,833,730</b>	<b>3,085,130</b>	<b>3,358,833</b>	<b>3,656,819</b>

### Balqa Governorate

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
Salt Qasabah	Salt Qasabah	Modari	905	961	1,062	1,174	1,297	1,434
		Yazeediyyeh	1,332	1,414	1,563	1,728	1,909	2,110
		Za'tari	1,539	1,634	1,806	1,996	2,206	2,438
		Hdaib	374	397	439	485	536	592
		Wadi Ennaqah	290	308	340	376	416	459
		Um Karubah	248	263	291	322	355	393
		Wadi Essahn	147	156	173	191	211	233
		Salt	90,865	96,484	106,631	117,846	130,239	143,937
			<b>95,700</b>	<b>101,618</b>	<b>112,305</b>	<b>124,116</b>	<b>137,170</b>	<b>151,596</b>
Salt Qasabah	Al-Ardha	Sbaihi	5,137	5,455	6,028	6662	7,363	8,137
		Bayyoodah Sharqiyyeh	730	775	857	947	1,046	1,156
		Siehan	1,373	1,458	1,611	1,781	1,968	2,175
		Elaiqoon	428	454	502	555	613	678
		Bayyoodah Gharbiyyeh	436	463	512	565	625	691
		BayyoodahSham aliyeh	445	473	522	577	638	705
		Khashfeh	407	432	478	528	583	645
		Jarriesh	274	291	322	355	393	434
		Azab	205	218	241	266	294	325
		Qsaib	520	552	610	674	745	824
		Bwaib	229	243	269	297	328	363
		Haqawah	856	909	1,005	1,110	1,227	1,356
		Maisarah	872	926	1,023	1,131	1,250	1,381
		Dhraissat	178	189	209	231	255	282
			<b>12,090</b>	<b>12,838</b>	<b>14,188</b>	<b>15,680</b>	<b>17,329</b>	<b>19,151</b>
Salt Qasabah	Allan & Zayy	Allan	3,491	3,707	4,097	4,528	5,004	5,530
		Zayy	3,624	3,848	4,253	4,700	5,194	5,741
		Rmemen	2,148	2,281	2,521	2,786	3,079	3,403
		Um Jauzeh	3,098	3,290	3,636	4,018	4,440	4,907

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
		Um El-Amad	1,432	1,521	1,680	1,857	2,053	2,268
		Da'am	570	605	669	739	817	903
		Sala'of	529	562	621	686	758	838
		Jal'ad	781	829	917	1,013	1,119	1,237
		Waseah	379	402	445	492	543	600
		Soomia	252	268	296	327	361	399
		Msherfah	252	268	296	327	361	399
		Dierah Sharqiyyeh	452	480	530	586	648	716
		Dierah Gharbiyyeh	292	310	343	379	419	463
			<b>17,300</b>	<b>18,370</b>	<b>20,302</b>	<b>22,437</b>	<b>24,797</b>	<b>27,404</b>
Salt Qasabah	Ira & Yarqha	Yarqha	5,788	6,146	6,792	7,507	8,296	9,169
		Ira	4,048	4,298	4,750	5,250	5,802	6,412
		Wadi Sho'aib	854	907	1,002	1,108	1,224	1,353
			<b>10,690</b>	<b>11,351</b>	<b>12,545</b>	<b>13,864</b>	<b>15,322</b>	<b>16,934</b>
Shoonah Janoobiyyah	Shoonah Janoobiyyah	Shoonah Janoobiyyah	4,299	4,565	5,045	5,576	6,162	6,810
		Shoonah Jadideh (Sokneh)	4,755	5,049	5,580	6,167	6,815	7,532
		Karamah	10,024	10,644	11,763	13,000	14,368	15,879
		Roudhah	9,821	10,428	11,525	12,737	14,077	15,557
		Ramah	5,213	5,535	6,118	6,761	7,472	8,258
		kafrain	2,244	2,383	2,633	2,910	3,216	3,555
		Joafet El-Kafrain	6,951	7,381	8,157	9,015	9,963	11,011
		Swaimch	4,583	4,866	5,378	5,944	6,569	7,260
			<b>47,890</b>	<b>50,851</b>	<b>56,199</b>	<b>62,110</b>	<b>68,642</b>	<b>75,861</b>
Dair Alla	Dair Alla	Dair Alla	5,602	5,948	6,574	7,265	8,030	8,874
		Twal Janoobi	8,525	9,052	10,004	11,056	12,219	13,504
		M'addi	3,644	3,869	4,276	4,726	5,223	5,772
		Dherar	7,567	8,035	8,880	9,814	10,846	11,987
		Muthallath El-Ardhah	1,871	1,987	2,196	2,427	2,682	2,964
		Damia	1,172	1,244	1,375	1,520	1,680	1,857
		Twal Shamali	4,732	5,025	5,553	6,137	6,783	7,496

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
		Khazma	3,328	3,534	3,905	4,316	4,770	5,272
		Debab	2,914	3,094	3,420	3,779	4,177	4,616
		Rwaihah	3,791	4,025	4,449	4,917	5,434	6,005
		Abu Ezzighan	661	702	776	857	947	1,047
		Dhahret Erramel	2,023	2,148	2,374	2,624	2,900	3,205
		Balaooneh	6,409	6,805	7,521	8,312	9,186	10,152
		Ghour Kebed	1,637	1,738	1,921	2,123	2,346	2,593
		Maisarat Fannosh	3,012	3,198	3,535	3,906	4,317	4,771
		Muthallath EL-Masri	552	586	648	716	791	874
			<b>57,440</b>	<b>60,992</b>	<b>67,406</b>	<b>74,496</b>	<b>82,330</b>	<b>90,989</b>
Ain Albasha	Ain Albasha	Ain Albasha	45,996	48,840	53,977	59,654	65,927	72,861
		Safoot	9,156	9,722	10,745	11,875	13,124	14,504
		Um Edananier	886	941	1,040	1,149	1,270	1403
		Karet Abu Nsair	6,945	7,374	8,150	9,007	9,954	11,001
		Moobes	3,327	3,533	3,904	4,315	4,769	5,270
		Shewahi El-Gharbi	2,787	2,959	3,271	3,615	3,995	4,415
		Salcehi	968	1,028	1,136	1,255	1,387	1,533
		Salhoob	2,490	2,644	2,922	3,229	3,569	3,944
		Um Njasah	893	948	1,048	1,158	1,280	1,415
		Sahlouyyeh	434	461	509	563	622	687
		Romman	1,796	1,907	2,108	2,329	2,574	2,845
		Abu Hamed	1,075	1,141	1,262	1,394	1,541	1,703
		Jaidiyyeh	542	576	636	703	777	859
		Baq'ah	77,245	82,022	90,648	100,181	110,718	122,362
		Heno	4,565	4,847	5,357	5,920	6,543	7,231
		Um Sendyaneh	245	260	288	318	351	388
			<b>159,350</b>	<b>169,204</b>	<b>186,999</b>	<b>206,666</b>	<b>228,401</b>	<b>252,422</b>
Mahes & Fuhais	Mahes & Fuhais	Mahes	14,383	15,272	16,879	18,654	20,616	22,784

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
		Fuhais	13,157	13,971	15,440	17,064	18,858	20,842
			<b>27,540</b>	<b>29,243</b>	<b>32,318</b>	<b>35,717</b>	<b>39,474</b>	<b>43,625</b>
<b>Governorate Total</b>			<b>428,000</b>	<b>454,466</b>	<b>502,263</b>	<b>555,086</b>	<b>613,465</b>	<b>677,984</b>

## Madaba Governorate

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
Madaba Qasabah	Madaba Qasabah	Ma'monia	6,380	6,734	7,368	8,062	8,821	9,652
		Fayha'a	1,787	1,886	2,064	2,258	2,471	2,703
		Wah (Mrejmet El-Hamed)	310	327	358	392	429	469
		Heialaleyeh (Falha)	2,749	2,902	3,175	3,474	3,801	4,159
		Hwayyet El-Balouneh	437	461	505	552	604	661
		Jubail	485	512	560	613	671	734
		Khatabiyyeh	1,310	1,383	1,513	1,655	1,811	1,982
		Khaldeyyeh (Abu Ezqal)	917	968	1,059	1,159	1,268	1,387
		Madaba	86,435	91,231	99,822	109,223	119,509	130,764
			<b>100,810</b>	<b>106,403</b>	<b>116,424</b>	<b>127,388</b>	<b>139,385</b>	<b>152,511</b>
Madaba Qasabah	Jrainah	Jrainah	3,645	3,847	4,210	4,606	5,040	5,514
		Ghernatah	1,810	1,910	2,090	2,287	2,503	2,738
		Ariesh	1,449	1,529	1,673	1,831	2,003	2,192
		Wasiyyeh	1,217	1,285	1,405	1,538	1,683	1,841
		Abu Rdaineh	139	147	161	176	192	210
			<b>8,260</b>	<b>8,718</b>	<b>9,539</b>	<b>10,438</b>	<b>11,421</b>	<b>12,496</b>
Madaba Qasabah	Maeen	Maeen	6,550	6,913	7,564	8,277	9,056	9,909
		Manshiyyet Maeen	1,963	2,072	2,267	2,481	2,714	2,970
		Hamamat Maeen	43	45	50	54	59	65
		Zarqa' Maeen	370	391	427	468	512	560
		Ain Eddieb	134	141	155	169	185	203
			<b>9,060</b>	<b>9,563</b>	<b>10,463</b>	<b>11,449</b>	<b>12,527</b>	<b>13,706</b>
Madaba Qasabah	Faisaliah	Faisaliah	6,101	6,440	7,046	7,709	8,436	9,230
		Syaghah	23	24	27	29	32	35
		Oyoon Moosa	41	43	47	52	57	62
		Libbeh	235	248	271	297	325	356

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
		Mkhait	50	53	58	63	69	76
			<b>6,450</b>	<b>6,808</b>	<b>7,449</b>	<b>8,151</b>	<b>8,918</b>	<b>9,758</b>
Dieban	Dieban	Dieban	7,131	7,527	8,235	9,011	9,860	10,788
		Safa	361	381	417	456	499	546
		Mesherfeh	424	448	490	536	586	641
		Alyeh	2,328	2,457	2,689	2,942	3,219	3,522
		Falha	439	463	507	555	607	664
		Um Shjaireh Sharqiyyeh	117	123	135	148	162	177
		Um Shjaireh Gharbiyyeh	85	90	98	107	118	129
		Rehaneih (Um Shajarah)	50	53	58	63	69	76
		Ara'er	55	58	64	70	76	83
		Dhaibeh Gharbiyyeh	366	386	423	462	506	554
		Mathlooth eh	350	369	404	442	484	529
		Annahda (Um Zabarah)	79	83	91	100	109	120
		Manshiyyeh	220	232	254	278	304	333
		Barzah	751	793	867	949	1,038	1,136
Dieban	Dieban	Qasmeia	320	338	370	404	442	484
		Shqaiq	1,772	1,870	2,046	2,239	2,450	2,681
		Qbaibeh	55	58	64	70	76	83
		Heno & Sakraneh	108	114	125	136	149	163
		Dhaibeh Sharqiyyeh	170	179	196	215	235	257
		Wadi El-Mujeb	63	66	73	80	87	95
		Meq'ad Ben Nasrallah	6	6	7	8	8	9
			<b>15,250</b>	<b>16,096</b>	<b>17,612</b>	<b>19,271</b>	<b>21,085</b>	<b>23,071</b>
Dieban	Areedh	Areedh	681	719	786	861	942	1,030
		Bake'a (Kuba'i)	54	57	62	68	75	82
		Hashemiyeh (Um sas)	15	16	17	19	21	23

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
		Atrooz	132	139	152	167	183	200
		Muhamadeh	15	16	17	19	21	23
		Azzahra'	289	305	334	365	400	437
		Namyeh	215	227	248	272	297	325
		Qrayyat	493	520	569	623	682	746
		Makawer	485	512	560	613	671	734
		Dair	721	761	833	911	997	1,091
		Balotah	494	521	571	624	683	747
		Jadedah	813	858	939	1,027	1,124	1,230
		Zayna	150	158	173	190	207	227
		Nasieb	37	39	43	47	51	56
		Jarwan (Amerah)	346	365	400	437	478	523
			<b>4,940</b>	<b>5,214</b>	<b>5,705</b>	<b>6,242</b>	<b>6,830</b>	<b>7,474</b>
		Mlaih	7,182	7,580	8,294	9,075	9,930	10,865
		Leb	3,973	4,193	4,588	5,020	5,493	6,011
		Dalhelet El-Hamaydeh	857	905	990	1,083	1,185	1,297
		Waleh	36	38	42	45	50	54
		Nozhet El-Waleh	419	442	484	529	579	634
		Gadeer	514	543	594	650	711	778
		Rashdeia	510	538	589	644	705	772
		Hayyadh	428	452	494	541	592	648
		Hiedan	135	142	156	171	187	204
		Kaldiyyeh	165	174	191	209	228	250
		Lusen & Rabt	366	386	423	462	506	554
		Munsaf (Mekher'ah)	327	345	378	413	452	495
		Alaqi	18	19	21	23	25	27
			<b>14,930</b>	<b>15,758</b>	<b>17,242</b>	<b>18,866</b>	<b>20,643</b>	<b>22,587</b>
<b>Governorate Total</b>			<b>159,700</b>	<b>168,561</b>	<b>184,435</b>	<b>201,804</b>	<b>220,809</b>	<b>241,603</b>

### Zarqa Governorate

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
Zarqa Qasabah	Zarqa Qasabah	Tafeh	863	916	1,013	1,119	1,237	1,367
		Rukban	220	234	258	285	315	348
		Khou	459	487	539	595	658	727
		Farwaneyeh	137	145	161	178	196	217
		Zarqa	491,951	522,372	577,310	638,026	705,128	779,287
			<b>493,630</b>	<b>524,154</b>	<b>579,280</b>	<b>640,204</b>	<b>707,534</b>	<b>781,946</b>
Zarqa Qasabah	Bierain	Bierain	1,461	1,551	1,714	1,895	2,094	2,314
		Um Rommaneh	1,332	1,414	1,563	1,728	1,909	2,110
		Kamshah	1,544	1,639	1,812	2,002	2,213	2,446
		Alook	784	832	920	1,017	1,124	1,242
		Sarroot	1,466	1,557	1,720	1,901	2,101	2,322
		Merheb	804	854	944	1,043	1,152	1,274
		Rojom Eshoak	859	912	1,008	1,114	1,231	1,361
		Naseryah	632	671	742	820	906	1,001
		Mekman	607	645	712	787	870	962
		Masarrah Sharqiyyeh	447	475	525	580	641	708
		MasarrahGharbiyyeh	536	569	629	695	768	849
		Makethat	30	32	35	39	43	48
		Khalleh	294	312	345	381	421	466
		Maqam Isa	648	688	760	840	929	1,026
		Ain Saber	727	772	853	943	1,042	1,152
		Biereh	414	440	486	537	593	656
		Reyad	544	578	638	706	780	862
Saharah	68	72	80	88	97	108		
Ewailiyyeh	173	184	203	224	248	274		

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
		Wadi Esswan	259	275	304	336	371	410
		Um El-Fat'ier	126	134	148	163	181	200
		Ain El-Hawaya	102	108	120	132	146	162
		Um Khashibeh	439	466	515	569	629	695
		Um El-Byar	514	546	603	667	737	814
			<b>14,810</b>	<b>15726</b>	<b>17380</b>	<b>19208</b>	<b>21228</b>	<b>23460</b>
Zarqa Qasabah	Dhlail	Dhlail	34,412	36540	40383	44630	49324	54511
		Qaser Hallabat El-Sharqi	2,269	2409	2663	2943	3252	3594
		Qaser Hallabat El-Gharbi	3,064	3253	3596	3974	4392	4854
		Dhaythem	320	340	376	415	459	507
		Sayeh Diab	340	361	399	441	487	539
		Mazari'e El-Hallabat	185	196	217	240	265	293
			40,590	43100	47633	52642	58179	64298
Zarqa Qasabah	Azraq	Azraq Shamali	5,891	6255	6913	7640	8444	9332
		Azraq Janoobi	2,188	2323	2568	2838	3136	3466
		Omari	555	589	651	720	795	879
		Ain El-Baidha	596	633	699	773	854	944
		Qaser Amrah	0	0	0	0	0	0
		Badiat El-Azraq	1,529	1,624	1,794	1,983	2,192	2,422
		Kaadat Selah Jaw (Moafaq Salti)	471	500	553	611	675	746
			11,230	11,924	13,179	14,565	16,096	17,789
Russeifa	Russeifa	Russeifa	283,475	301,004	332,661	367,647	406,313	449,045
		Abu Saiah	2,491	2,645	2,923	3,231	3,570	3,946
		Mukhayyam Hetten	47,924	50,887	56,239	62,154	68,691	75,915
			<b>333,890</b>	<b>354,537</b>	<b>391,824</b>	<b>433,032</b>	<b>478,574</b>	<b>528,906</b>
Hashemiyah	Hashemiyah	Hashemiyah	31,712	33,673	37,214	41,128	45,454	50,234
		Sokhneh	15,793	16,770	18,533	20,482	22,637	25,017
		Abu Ezziegan	2,648	2,812	3,107	3,434	3,795	4,195

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
		Doqarah	2,325	2,469	2,728	3,015	3,332	3,683
		Ain El-Nemreh	163	173	191	211	234	258
		Ghraiseh	830	881	974	1,076	1,190	1,315
		Um Essalleeh	2,664	2,829	3,126	3,455	3,818	4,220
		Qnayyeh	685	727	804	888	982	1,085
		Dab'an	302	321	354	392	433	478
		Tawahien Adwan	59	63	69	77	85	93
		Hasab	59	63	69	77	85	93
		Rahayal	410	435	481	532	588	649
			<b>57,650</b>	<b>61,215</b>	<b>67,653</b>	<b>74,768</b>	<b>82,631</b>	<b>91,322</b>
<b>Governorate Total</b>			<b>951,800</b>	<b>1,010,656</b>	<b>1,116,948</b>	<b>1,234,418</b>	<b>1,364,243</b>	<b>1,507,722</b>

### Irbid Governorate

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
Qasabah Irbid	Irbid	Howwarah	15,622	16,588	18,333	20,261	22,391	24,746
		Kofor Yooba	13,780	14,632	16,171	17,872	19,751	21,829
		Bait Ras	22,078	23,443	25,909	28,634	31,645	34,973
		Boshra	13,936	14,798	16,354	18,074	19,975	22,076
		Mghayyer	10,625	11,282	12,469	13,780	15,229	16,831
		Al'al	5,343	5,673	6,270	6,929	7,658	8,464
		Sal	8,505	9,031	9,981	11,030	12,190	13,473
		Hakama	9,093	9,655	10,671	11,793	13,033	14,404
		Soom	6,311	6,701	7,406	8,185	9,046	9,997
		Zahar	5,701	6,054	6,690	7,394	8,171	9,031
		Bait Yafa	9,280	9,854	10,890	12,036	13,301	14,700
		Fo'arah	4,062	4,313	4,767	5,268	5,822	6,435
		Doaqarah	5,779	6,136	6,782	7,495	8,283	9,154
		Jijien	3,227	3,427	3,787	4,185	4,625	5,112
		Kofor Jayez	3,818	4,054	4,480	4,952	5,472	6,048
		Maro	3,578	3,799	4,199	4,640	5,128	5,668
		Teqbel	612	650	718	794	877	969
		Kofor Rahta	1,536	1,631	1,803	1,992	2,202	2,433
		As'ara	1,188	1,261	1,394	1,541	1,703	1,882
		Jamhah	2,568	2,727	3,014	3,331	3,681	4,068
		Natfeh	1,652	1,754	1,939	2,143	2,368	2,617
		Ham	1,248	1,325	1,465	1,619	1,789	1,977
		Um El-Jadayel	1,083	1,150	1,271	1,405	1,552	1,716
Hoor	2,432	2,582	2,854	3,154	3,486	3,852		
Irbid			307,033	326,019	360,307	398,200	440,079	486,363
			<b>460,090</b>	<b>488,540</b>	<b>539,921</b>	<b>596,705</b>	<b>659,461</b>	<b>728,817</b>
Ramtha	Ramtha	Ramtha	87,499	92,910	102,681	113,480	125,415	138,605
		Torraha	18,183	19,307	21,338	23,582	26,062	28,803
		Shajarah	14,115	14,988	16,564	18,306	20,231	22,359
		Emrawah	4,622	4,908	5,424	5,994	6,625	7,322

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
		Bwaidhah	6,677	7,090	7,836	8,660	9,570	10,577
		Dnaibeh	2,594	2,754	3,044	3,364	3,718	4,109
			<b>133,690</b>	<b>141,957</b>	<b>156,887</b>	<b>173,387</b>	<b>191,622</b>	<b>211,775</b>
Koorah	Koorah	Dair Abi Sa'id	16,896	17,941	19,828	21,913	24,218	26,765
		Jdaitta	13,975	14,839	16,400	18,125	20,031	22,137
		Kofor El-Ma'	12,052	12,797	14,143	15,631	17,274	19,091
		Ashrafiyyeh	10,474	11,122	12,291	13,584	15,013	16,592
		Kofor Awan	9,853	10,462	11,563	12,779	14,123	15,608
		Kofor Abil	8,093	8,593	9,497	10,496	11,600	12,820
		Sammo'	7,610	8,081	8,930	9,870	10,908	12,055
		Tebneh	6,934	7,363	8,137	8,993	9,939	10,984
		Bait Iedes	5,875	6,238	6,894	7,619	8,421	9,306
Koorah	Koorah	Kofor Rakeb	5,147	5,465	6,040	6,675	7,377	8,153
		Jeffien	4,379	4,650	5,139	5,679	6,277	6,937
		Jenien Essafa	4,482	4,759	5,260	5,813	6,424	7,100
		Zmal	3,710	3,939	4,354	4,812	5,318	5,877
		Kofor Kiefia	739	785	867	958	1,059	1,171
		Abu El-Qain	633	672	743	821	907	1,003
		Roqqah	256	272	300	332	367	406
		Sowwan	16	17	19	21	23	25
		Rahwah	223	237	262	289	320	353
		Kherbet EL-Hawi	9	10	11	12	13	14
		Rkhayem	154	164	181	200	221	244
		Iskayeen	20	21	23	26	29	32
			<b>111,530</b>	<b>118,427</b>	<b>130,882</b>	<b>144,647</b>	<b>159,859</b>	<b>176,672</b>
Bani Kenanah	Bani Kenanah	Sama El-Roosan	3,487	3,703	4,092	4,522	4,998	5,524
		Kofor Soom	8,377	8,895	9,831	10,864	12,007	13,270
		hatem	6,629	7,039	7,779	8,597	9,502	10,501
		Saham	7,226	7,673	8,480	9,372	10,357	11,447
		Malka	7,784	8,265	9,135	10,095	11,157	12,330
		Hartha	4,916	5,220	5,769	6,376	7,046	7,787
		Kharja	5,283	5,610	6,200	6,852	7,572	8,369
		Um Qais	4,811	5,108	5,646	6,240	6,896	7,621

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
		Samar	3,852	4,090	4,520	4,996	5,521	6,102
		Hariema	4,522	4,802	5,307	5,865	6,482	7,163
		Yebla	4,564	4,846	5,356	5,919	6,542	7,230
		Rfaid	2,532	2,689	2,971	3,284	3,629	4,011
		Mansoorah	4,404	4,676	5,168	5,712	6,312	6,976
		Mkhaibeh El-Tehta	3,051	3,240	3,580	3,957	4,373	4,833
		Aqraba	3,070	3,260	3,603	3,982	4,400	4,863
		Hebras	4,374	4,644	5,133	5,673	6,269	6,929
		Hemah Aurdinyah	1,941	2,061	2,278	2,517	2,782	3,075
		(Mkhaibeh El-Foaqa)	0	0	0	0	0	0
		Azriet	930	988	1,091	1,206	1,333	1,473
		Abu El-Loqas	1,549	1,645	1,818	2,009	2,220	2,454
		Mzairceb	1,466	1,557	1,720	1,901	2,101	2,322
		Esheh	179	190	210	232	257	284
		Bareshta	214	227	251	278	307	339
		yarmook	1,034	1,098	1,213	1,341	1,482	1,638
		Khrayybeh	1,747	1,855	2,050	2,266	2,504	2,767
		Ebder	2,838	3,013	3,330	3,681	4,068	4,496
		Qasfah	882	937	1,035	1,144	1,264	1,397
		Saileh	871	925	1,022	1,130	1,248	1,380
		Zaweh	1,047	1,112	1,229	1,358	1,501	1,659
			<b>93,580</b>	<b>99,367</b>	<b>109,817</b>	<b>121,367</b>	<b>134,131</b>	<b>148,238</b>
Aghwar Shamalyah	Aghwar Shamalyah	Shoonch Shamalyah	17,597	18,685	20,650	22,822	25,222	27,875
		Mashari'e	22,394	23,779	26,280	29,043	32,098	35,474
		Krayymeh	19,272	20,464	22,616	24,994	27,623	30,528
		Wadi El-Raian	6,616	7,025	7,764	8,580	9,483	10,480
		Shaikh Hussein	8,682	9,219	10,188	11,260	12,444	13,753
		Manshiyyeh	7,786	8,267	9,137	10,098	11,160	12,334
		Waqqas	6,387	6,782	7,495	8,283	9,155	10,117
		Adasiyyeh	2,971	3,155	3,487	3,853	4,258	4,706
		Tabaqat Fahl	1,038	1,102	1,218	1,346	1,488	1,644
		Baqoorah	698	741	819	905	1,000	1,106
		Wadi El-Arab	284	302	333	368	407	450

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
		Abu Saydo	3,653	3,879	4,287	4,738	5,236	5,787
		Siaikhat	889	944	1,043	1,153	1,274	1,408
		Abu Habeel	974	1,034	1,143	1,263	1,396	1,543
		Zmaliyyeh	1,073	1,139	1,259	1,392	1,538	1,700
		Marzeh	1,204	1,278	1,413	1,562	1,726	1,907
		Abu Ziad	60	64	70	78	86	95
		Majed	202	214	237	262	290	320
		Sakneh	488	518	573	633	699	773
		Qarn	921	978	1,081	1,194	1,320	1,459
		Karkamah	301	320	353	390	431	477
		Sbierch	21	22	25	27	30	33
		Feddein	859	912	1,008	1114	1,231	1,361
			<b>104,370</b>	<b>110,824</b>	<b>122,479</b>	<b>135,361</b>	<b>149,597</b>	<b>165,330</b>
Bani Obeid	Bani Obeid	Hoson	25,093	26,645	29,447	32,544	35,967	39,749
		No'ayymeh	15,240	16,182	17,884	19,765	21,844	24,141
		Sarieh	23,532	24,987	27,615	30,519	33,729	37,276
		Aidoon	22,767	24,175	26,717	29,527	32,633	36,065
		Ketem	6,752	7,170	7,924	8,757	9,678	10,696
		Shatna	341	362	400	442	489	540
		Aliah	532	565	624	690	763	843
		Mukhayyam Shahed Azmi	20,353	21,612	23,884	26,396	29,173	32,241
		El-Mufti (Hoson)	0	0	0	0	0	0
			<b>114,610</b>	<b>121,697</b>	<b>134,496</b>	<b>148,641</b>	<b>164,274</b>	<b>181,551</b>
Mazar Shamali	Mazar Shamali	Mazar Shamali	14,839	15,757	17,414	19,245	21,269	23,506
		Dair Yoosef	7,016	7,450	8,233	9,099	10,056	11,114
		Rhaba	9,144	9,709	10,731	11,859	13,106	14,485
		Enbeh	7,958	8,450	9,339	10,321	11,406	12,606
		Habka	2,805	2,978	3,292	3,638	4,020	4,443
		Johfiyyeh	2,966	3,149	3,481	3,847	4,251	4,698
		Zoobyia	3,416	3,627	4,009	4,430	4,896	5,411
		Samad	1,297	1,377	1,522	1,682	1,859	2,055
Mazar Shamali	Mazar Shamali	Hoafa El-Mazar	2,810	2,984	3,298	3,644	4,028	4,451
		Z'atara	750	796	880	973	1,075	1,188

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
		Ibrahimia (Sarras)	763	810	895	990	1,094	1,209
		Rahmeh	336	357	394	436	482	532
			<b>54,100</b>	<b>57,445</b>	<b>63,487</b>	<b>70,164</b>	<b>77,543</b>	<b>85,698</b>
Taybeh	Taybeh	Taybeh	15,570	16,533	18,272	20,193	22,317	24,664
		Samma	10,540	11,192	12,369	13,670	15,107	16,696
		Dair Ess'eneh	5,941	6,308	6,972	7,705	8,515	9,411
		Makhraba	1,531	1,626	1,797	1,986	2,194	2,425
		Mendah	1,274	1,353	1,495	1,652	1,826	2,018
		Zabdah El-Wastiyyeh	436	463	512	565	625	691
		Abser Abu Ali	388	412	455	503	556	615
			<b>35,680</b>	<b>37,886</b>	<b>41,871</b>	<b>46,274</b>	<b>51,141</b>	<b>56,520</b>
Wasfiyyah	Wasfiyyah	Kofor Asad	9,875	10,486	11,588	12,807	14,154	15,643
		Qmaim	6,256	6,643	7,341	8,114	8,967	9,910
		Hoafa El-Wastiyyeh	4,236	4,498	4,971	5,494	6,072	6,710
		Qom	1,513	1,607	1,776	1,962	2,169	2,397
		Kofor An	3,166	3,362	3,715	4,106	4,538	5,015
		Kharaj	2,594	2,754	3,044	3,364	3,718	4,109
		Saidoor	1,810	1,922	2,124	2,347	2,594	2,867
			<b>29,450</b>	<b>31,271</b>	<b>34,560</b>	<b>38,195</b>	<b>42,212</b>	<b>46,651</b>
<b>Governorate Total</b>			<b>1,137,100</b>	<b>1,207,414</b>	<b>1,334,399</b>	<b>1,474,739</b>	<b>1,629,839</b>	<b>1,801,251</b>

## Mafrq Governorate

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
Mafrq Qasabah	Mafrq	Aidoon	2,608	2,778	3,085	3,427	3,806	4,227
		Um Enna'am Sharqiyyeh	1,591	1,694	1,882	2,090	2,322	2,579
		Um Enna'am Gharbiyyeh	1,436	1,529	1,699	1,887	2,096	2,328
		Hayyan El-Meshref	1,172	1,248	1,386	1,540	1,710	1,900
		Mazzeh	1,091	1,162	1,291	1,433	1,592	1,768
		Ghadier Abyadh	726	773	859	954	1,059	1,177
		Bwaidhet El-Hwamdeh	1,724	1,836	2,039	2,265	2,516	2,794
		Teeb Isem	500	533	591	657	730	810
		Rojom Essabi'e El-Shamali	466	496	551	612	680	755
		Mafrq	58,736	62,555	69,481	77,173	85,717	95,207
				<b>70,050</b>	<b>74,605</b>	<b>82,865</b>	<b>92,039</b>	<b>102,228</b>
Mafrq Qasabah	Bal'ama	Bal'ama	10,551	11,237	12,481	13,863	15,398	17,102
		Zaniyyeh	2,612	2,782	3,090	3,432	3,812	4,234
		Hayyan Rwaibedh Gharbi	1,278	1,361	1,512	1,679	1,865	2,072
		Kherbeh Samra(Raudit Al-Amir Mohamad)	3,295	3,509	3,898	4,329	4,809	5,341
		Mazra'ah	2,504	2,667	2,962	3,290	3,654	4,059
		Nozhah	891	949	1,054	1,171	1,300	1,444
		Bostan	497	529	588	653	725	806
		Khraisan	197	210	233	259	287	319
		Manshiyyet Alaian (Alkhan)	32	34	38	42	47	52
		Nemreh	379	404	448	498	553	614
		Marajem	237	252	280	311	346	384
		Um Swaiweench	293	312	347	385	428	475
		Hamaneh El-Qadiemeh	6	6	7	8	9	10
		Hamaneh El-Jadiedeh	616	656	729	809	899	998
		Dahreiah	499	531	590	656	728	809
Shraifiyyeh	18	19	21	24	26	29		

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
		Hayyan Rwaibedh Sharqi	1,665	1,773	1,970	2,188	2,430	2,699
			<b>25,570</b>	<b>27,233</b>	<b>30,248</b>	<b>33,596</b>	<b>37,316</b>	<b>41,447</b>
Maftaq Qasabah	Irbab	Irbab	4,418	4,705	5,226	5,805	6,447	7,161
		Dajaniyyeh	4,110	4,377	4,862	5,400	5,998	6,662
		Hwaishan	266	283	315	349	388	431
		Mo'ammariyyeh	1,405	1,496	1,662	1,846	2,050	2,277
		Um Kheroba	109	116	129	143	159	177
		Bwaidhet Elaimat(Bwaidhah Sharqiyyeh)	995	1,060	1,177	1,307	1,452	1,613
		BwaidhahGhrbiyyeh	609	649	720	800	889	987
		Hamamet Elaimat	194	207	229	255	283	314
		Hamamet Omoosh	692	737	819	909	1,010	1,122
		Doqomseh	662	705	783	870	966	1,073
		Nadreh	537	572	635	706	784	870
		Medwar	363	387	429	477	530	588
		Um Btaimeh	1,050	1,118	1,242	1,380	1,532	1,702
		Maftaq Qasabah	Irbab	Dahal	615	655	728	808
Sahah	367			391	434	482	536	595
Hamied	139			148	164	183	203	225
Karm	433			461	512	569	632	702
Ain Bani Hasan	1,359			1,447	1,608	1,786	1,983	2,203
Zafaraneh	111			118	131	146	162	180
Mnifa	225			240	266	296	328	365
Abu El-Soos	57			61	67	75	83	92
Um Hysmasa	188			200	222	247	274	305
Khatlah	76			81	90	100	111	123
Kharab El-Matwi	114			121	135	150	166	185
Ain Ennabi	857			913	1,014	1,126	1,251	1,389
Qadam	419			446	496	551	611	679
					<b>20,370</b>	<b>21,695</b>	<b>24,096</b>	<b>26,764</b>

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
Mafraq Qasabah	Manshiyah	Manshiyyet Bani Hasan	8,354	8,897	9,882	10,976	12,192	13,541
		Dair Waraq	397	423	470	522	579	644
		Um Elloolo	339	361	401	445	495	549
			<b>9,090</b>	<b>9,681</b>	<b>10,753</b>	<b>11,943</b>	<b>13,266</b>	<b>14,734</b>
Badiyah Shamaliyah	Salhiya	Safawi	2,306	2,456	2,728	3,030	3,365	3,738
		Manarah	2,149	2,289	2,542	2,824	3,136	3,483
		Salhiya	2,220	2,364	2,626	2,917	3,240	3,598
		Hamiediyyeh	1,609	1,714	1,903	2,114	2,348	2,608
		Ashrafiyyeh	1,154	1,229	1,365	1,516	1,684	1,871
		Beshriyyeh	1,596	1,700	1,888	2,097	2,329	2,587
		Bani Hashem (Hamra Esahim)	1,125	1,198	1,331	1,478	1,642	1,824
		Rahbet Rakkad	978	1,042	1,157	1,285	1,427	1,585
		Raudit Al-Amir Hamzeh (Hliut Masarha)	1,692	1,802	2,002	2,223	2,469	2,743
		Nayfeh	1,387	1,477	1,641	1,822	2,024	2,248
		Zamlet Al-Amir Ghazi	1,157	1,232	1,369	1,520	1,688	1,875
		Sa'adah	1,280	1,363	1,514	1,682	1,868	2,075
		Bostaneh	961	1,023	1,137	1,263	1,402	1,558
		Aliet El-Shwa'ar	108	115	128	142	158	175
		Hashimiyyeh Sharqiyyeh	154	164	182	202	225	250
		Manshiyyet Kalefeh	121	129	143	159	177	196
		Kaidat Al-Amir Hassan Al-Jauiah	450	479	532	591	657	729
Badiat El-Safawi	503	536	595	661	734	815		
			<b>20,950</b>	<b>22,312</b>	<b>24,783</b>	<b>27,526</b>	<b>30,574</b>	<b>33,958</b>
Badiyah Shamaliyah	Sabha	Sabha	6,283	6,692	7,432	8,255	9,169	10,184
		Dafyaneh	2,126	2,264	2,515	2,793	3,103	3,446
		Sab'e Aseyar	1,563	1,665	1,849	2,054	2,281	2,534
		Koam Erraf	886	944	1,048	1,164	1,293	1,436
		Manshiyyet Qoblan	437	465	517	574	638	708

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
		Feisaliyyeh	670	714	793	880	978	1,086
		Harara	205	218	243	269	299	332
			<b>12,170</b>	<b>12,961</b>	<b>14,396</b>	<b>15,990</b>	<b>17,760</b>	<b>19,727</b>
Badiah Shamaliyah	Um Al-Jemal	Um Al-Jemal	3,156	3,361	3,733	4,147	4,606	5,116
		Roadhet Basmah	5,579	5,942	6,600	7,330	8,142	9,043
		Koam El-Ahmar	2,808	2,991	3,322	3,689	4,098	4,552
		Aqeb	1,212	1,291	1,434	1,592	1,769	1,965
		Amra & Amiereh	3,113	3,315	3,682	4,090	4,543	5,046
		Sa'iediyeh	1,458	1,553	1,725	1,916	2,128	2,363
		Rasm El-Hesan	302	322	357	397	441	490
		Zuhoor	109	116	129	143	159	177
		Rahmat	183	195	216	240	267	297
			<b>17,920</b>	<b>19,085</b>	<b>21,198</b>	<b>23,545</b>	<b>26,152</b>	<b>29,047</b>
Badiah Shamaliyah	Dair Al Kahf	Dair Al Kahf	1,584	1,687	1,874	2,081	2,312	2,568
		Rfa'iyyat	1,238	1,319	1,464	1,627	1,807	2,007
		Roadhet Al-Amir Ali Bin Al-Hussein (Abu Frth)	1,233	1,313	1,459	1,620	1,799	1,999
		Jubbeiah	1,268	1,350	1,500	1,666	1,850	2,055
		Dair El-Qenn	237	252	280	311	346	384
		Methnat Rajel	232	247	274	305	339	376
		Qasem	986	1,050	1,166	1,296	1,439	1,598
		Jad'ah	84	89	99	110	123	136
		Tal Ermah	489	521	578	642	714	793
		Arainbet Enaimat	144	153	170	189	210	233
		Medwer El-Qenn	299	318	354	393	436	485
		Ethlag	167	178	198	219	244	271
		Khsha' El-Qenn	278	296	329	365	406	451
		Swailmeh	11	12	13	14	16	18
		Mansoorah	129	137	153	169	188	209
		Mrajeeb	70	75	83	92	102	113
Um Hussein	245	261	290	322	358	397		

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
		Menyasah	456	486	539	599	665	739
			<b>9,150</b>	<b>9,745</b>	<b>10,824</b>	<b>12,022</b>	<b>13,353</b>	<b>14,832</b>
Badiyah Sharnaiyah	Um-Elqotain	Um-Elqotain	5,349	5,697	6,328	7,028	7,806	8,670
		Khsha' Slaiteen	1,457	1,552	1,724	1,914	2,126	2,362
		Mkaifteh	2,807	2,990	3,321	3,688	4,096	4,550
		Ma'zoolah	237	252	280	311	346	384
		Manshiyyet El-Qhano	441	470	522	579	644	715
		Ghadeer El-Naqah	26	28	31	34	38	42
		Husseiniyyeh	100	107	118	131	146	162
		Oudeh	363	387	429	477	530	588
			<b>10,780</b>	<b>11,481</b>	<b>12,752</b>	<b>14,164</b>	<b>15,732</b>	<b>17,474</b>
Badiyah Sh.Gh.	Badiyah Sh.Gh.	Za'tary	6,218	6,622	7,355	8,170	9,074	10,079
		Ba'ej	4,833	5,147	5,717	6,350	7,053	7,834
		Um Essrab	2,953	3,145	3,493	3,880	4,309	4,787
		Mansoorah	3,195	3,403	3,779	4,198	4,663	5,179
		Thoghret El-Jobb	2,272	2,420	2,688	2,985	3,316	3,683
Badiyah Sh.Gh.	Badiyah Sh.Gh.	Zubaidyyeh	1,273	1,356	1,506	1,673	1,858	2,063
		Nahdhah	1,370	1,459	1,621	1,800	1,999	2,221
		Manshiyyet Essoltah	2,605	2,774	3,082	3,423	3,802	4,223
		Meferdad	1,095	1,166	1,295	1,439	1,598	1,775
		Hwaijeh	705	751	834	926	1,029	1,143
		Rodhet Errwai'i	401	427	474	527	585	650
		Fohayhileh	218	232	258	286	318	353
		Meshref	765	815	905	1005	1116	1240
		Rodhet Abu Heyal	900	959	1065	1183	1313	1459
		Sorrah	77	82	91	101	112	125
			<b>28,880</b>	<b>30,758</b>	<b>34,163</b>	<b>37,945</b>	<b>42,146</b>	<b>46,812</b>
Badiyah Sh.Gh.	Serhan	Sama Serhan	4,959	5,281	5,866	6,516	7,237	8,038
		Mghayyer Serhan	7,385	7,865	8,736	9,703	10,777	11,971
		Rba' Serhan	1,093	1,164	1,293	1,436	1,595	1,772

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
		Jaber Serhan	4,239	4,515	5,014	5,570	6,186	6,871
		Manshiyyet K'aiber	593	632	701	779	865	961
		Somayya Serhan	279	297	330	367	407	452
		Zamlett Atterfi	516	550	610	678	753	836
		Matalleh	905	964	1,071	1,189	1,321	1,467
		Harfosheia	141	150	167	185	206	229
			<b>20,110</b>	<b>21,418</b>	<b>23,789</b>	<b>26,423</b>	<b>29,348</b>	<b>32,597</b>
Badiyah Sh.Gh.	Hosha	Hosha	2,169	2,310	2,566	2,850	3,165	3,516
		Hamra	7,512	8,000	8,886	9,870	10,963	12,176
		Fa'	1,754	1,868	2,075	2,305	2,560	2,843
		Harsh	1,281	1,364	1,515	1,683	1,869	2,076
		Braiqqa	977	1,041	1,156	1,284	1,426	1,584
		Akaidar	987	1,051	1,168	1,297	1,440	1,600
		Khanasri	859	915	1,016	1,129	1,254	1,392
		Swailmeh	1,327	1,413	1,570	1,744	1,937	2,151
		Mshairfeh	192	204	227	252	280	311
		Dandania	293	312	347	385	428	475
		Darzeah	79	84	93	104	115	128
			<b>17,430</b>	<b>18,563</b>	<b>20,619</b>	<b>22,901</b>	<b>25,437</b>	<b>28,253</b>
Badiyah Sh.Gh.	Khaldiyah	Khaldiyah	12,710	13,536	15,035	16,700	18,549	20,602
		Mabrookah	5,246	5,587	6,206	6,893	7,656	8,503
		Mshrfeh	4,249	4,525	5,026	5,583	6,201	6,887
		Nasaryyah	263	280	311	346	384	426
		Khaldiyah Qademeh	3,302	3,517	3,906	4,338	4,819	5,352
			<b>25,770</b>	<b>27,446</b>	<b>30,484</b>	<b>33,859</b>	<b>37,608</b>	<b>41,771</b>
Rwaished	Rwaished	Rwaished	5,179	5,516	6,126	6,805	7,558	8,395
		Manshiyyet El-Gheith	1,328	1,414	1,571	1,745	1,938	2,153
		Salheiat Enneim	169	180	200	222	247	274
		Rodah (Roadhet Bndan)	49	52	58	64	72	79
Rwai shed	Rwai shed	Reesheh Gharbiyyeh	17	18	20	22	25	28

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
		Rokban	14	15	17	18	20	23
		Fhaidhah	77	82	91	101	112	125
		Reesheh Sharqiyyeh	4	4	5	5	6	6
		Karamah	3,533	3,763	4,179	4,642	5,156	5,727
		Jeser Rwaished	295	314	349	388	431	478
		Wassad	385	410	455	506	562	624
		Burqa'	279	297	330	367	407	452
		Anka	285	304	337	374	416	462
		Demathah	182	194	215	239	266	295
		Bostaneh	209	223	247	275	305	339
		Um Trfah	55	59	65	72	80	89
			<b>12,060</b>	<b>12,844</b>	<b>14,266</b>	<b>15,846</b>	<b>17,600</b>	<b>19,548</b>
<b>Governorate Total</b>			<b>300,300</b>	<b>319,828</b>	<b>355,236</b>	<b>394,564</b>	<b>438,247</b>	<b>486,765</b>

## Jarash Governorate

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
Jarash Qasabah	Jarash	Soof	14,574	15,686	17,730	20,040	22,652	25,604
		Sakeb	12,771	13,745	15,536	17,561	19,849	22,436
		Kofor Khall	7,007	7,541	8,524	9,635	10,891	12,310
		Ketteh	7,294	7,850	8,873	10,030	11,337	12,814
		Raimoon	7,839	8,437	9,536	10,779	12,184	13,772
		Baliela	6,195	6,667	7,536	8,519	9,629	10,883
		Qafqafa	4,550	4,897	5,535	6,257	7,072	7,993
		Nahleh	3,926	4,225	4,776	5,398	6,102	6,897
		Dair Elliyyat	3,029	3,260	3,685	4,165	4,708	5,321
		Hadadeh	2,776	2,988	3,377	3,817	4,315	4,877
		Meqebleh	2,072	2,230	2,521	2,849	3,220	3,640
		Kfair	2,203	2,371	2,680	3,029	3,424	3,870
		Zaqreet	417	449	507	573	648	733
		Ejbarat	2,229	2,399	2,712	3,065	3,464	3,916
		Asfoor	961	1,034	1,169	1,321	1,494	1,688
		Rashaydeh	1,872	2,015	2,277	2,574	2,910	3,289
		Um Rameh	130	140	158	179	202	228
		Enabeh	102	110	124	140	159	179
		Jabba	618	665	752	850	961	1,086
		Um Ezzaitoon	661	711	804	909	1,027	1,161
		Nabi Hood	1,173	1,262	1,427	1,613	1,823	2,061
		Hasainiyyat	398	428	484	547	619	699
		Um Qontarah	658	708	800	905	1,023	1,156
Najdeh	321	345	391	441	499	564		
Majar	844	908	1,027	1,161	1,312	1,483		
Abarah	407	438	495	560	633	715		
Jamla	935	1,006	1,137	1,286	1,453	1,643		
Qraia'	302	325	367	415	469	531		

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
		Dibbeen	49	53	60	67	76	86
		Ryashi	711	765	865	978	1,105	1,249
		Hazeah	323	348	393	444	502	567
		Amamah	190	204	231	261	295	334
		Shak Mfarrej	102	110	124	140	159	179
		Jnaideyyeh(Mshairfeh Sharqiyyeh)	877	944	1067	1206	1363	1541
		Fayha' (Mshairfeh El-Westa)	532	573	647	732	827	935
		Mshairfeh Gharbiyyeh	2,180	2,346	2,652	2,998	3,388	3,830
		Mukhyyam Soof	13,299	14,313	16,179	18,287	20,670	23,364
		Mukhyyam Ghazzeh	17,750	19,104	21,593	24,407	27,588	31,183
		Mashtal Faisal	422	454	513	580	656	741
		Mansheiat Hashem	2,947	3,172	3,585	4,052	4,580	5,177
		Jarash	39,504	42,517	48,058	54,321	61,400	69,401
					<b>165,150</b>	<b>177,746</b>	<b>200,909</b>	<b>227,092</b>
Jarash Qasabah	Mesabab	Mastabah	4,325	4,655	5,261	5,947	6,722	7,598
		Mersi'e	3,900	4,197	4,744	5,363	6,062	6,852
		Jebbah	4,097	4,409	4,984	5,634	6,368	7,198
		Tal'et Erroz	1,004	1,081	1,221	1,381	1,560	1,764
		Rahmaniyyeh	682	734	830	938	1,060	1,198
		Raieh	682	734	830	938	1,060	1,198
			<b>14,690</b>	<b>15,810</b>	<b>17,871</b>	<b>20,200</b>	<b>22,832</b>	<b>25,808</b>
Jarash Qasabah	Borna	Borma	5,575	6,000	6,782	7,666	8,665	9,794
		Mansorah (Khshaibeh)	1,308	1,408	1,591	1,799	2,033	2,298
		Jazzazeh	1,470	1,582	1,788	2,021	2,285	2,583
		Majdal	769	828	936	1,057	1,195	1,351
		Alaymoon	655	705	797	901	1,018	1,151
		Hamta	1,133	1,219	1,378	1,558	1,761	1,990
		Fawara	825	888	1,004	1,134	1,282	1,449
		Hoonch	125	135	152	172	194	220
			<b>11,860</b>	<b>12,765</b>	<b>14,428</b>	<b>16,308</b>	<b>18,434</b>	<b>20,836</b>

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
Governorate Total			191,700	206,321	233,208	263,600	297,952	336,781

### Ajlon Governorate

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
Ajlun Qasabah	Ajlun	Anjarah	21,794	23,246	25,884	28,822	32,093	35,735
		Ain Janna	10,841	11,563	12,876	14,337	15,964	17,776
		Hashemiyyeh	8,056	8,593	9,568	10,654	11,863	13,209
		Wahadneh	5,842	6,231	6,938	7,726	8,603	9,579
		Halawah	7,042	7,511	8,364	9,313	10,370	11,547
		Dair Smadiyyeh Shamali	171	182	203	226	252	280
		Keshiebeh El-Foqa	489	522	581	647	720	802
		Gabal Aghder	718	766	853	950	1,057	1,177
		Shkarah	1,229	1,311	1,460	1,625	1,810	2,015
		Fakhreh	162	173	192	214	239	266
		Mehnah	1,062	1,133	1,261	1,404	1,564	1,741
		Shtafaina	739	788	878	977	1,088	1,212
		Tayyarah	275	293	327	364	405	451
		Um El-Yanabie'	273	291	324	361	402	448
		Sakhneh	239	255	284	316	352	392
		Hanash	9	10	11	12	13	15
		Kerbet Essooq	118	126	140	156	174	193
		Zarra'ah	327	349	388	432	482	536
		Kofor Eddorrah	2	2	2	3	3	3
		Sarabees	9	10	11	12	13	15
		Um El-Khashab	45	48	53	60	66	74
		Khelet Salem	56	60	67	74	82	92
		Za'tarah	78	83	93	103	115	128
		Abu Ezzaitoon	2	2	2	3	3	3
		Lasteb	24	26	29	32	35	39
Sofsafah	408	435	485	540	601	669		
Dair Smadiyyeh Janoobi	74	79	88	98	109	121		

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
		Sowwan	41	44	49	54	60	67
		Khelet Wardeh	137	146	163	181	202	225
		Ajlun	9,018	9,619	10,710	11,926	13,280	14,787
			<b>69,280</b>	<b>73,896</b>	<b>82,282</b>	<b>91,621</b>	<b>102,019</b>	<b>113,597</b>
Ajlun Qasabah	Sakhrat	Sakhrat	12,736	13,585	15,126	16,843	18,754	20,883
		Ebbien	8,686	9,265	10,316	11,487	12,791	14,242
		Ebellien	1,470	1,568	1,746	1,944	2,165	2,410
		Samta	716	764	850	947	1,054	1,174
		Ras Moneef	1,828	1,950	2,171	2,417	2,692	2,997
		Dair El-Barak	74	79	88	98	109	121
			<b>25,510</b>	<b>27,210</b>	<b>30,298</b>	<b>33,736</b>	<b>37,565</b>	<b>41,828</b>
Ajlun Qasabah	Orjan	Orjan	6,266	6,683	7,442	8,287	9,227	10,274
		Ba'oon	4,585	4,890	5,446	6,064	6,752	7,518
		Rasoon	2,569	2,740	3,051	3,397	3,783	4,212
		Oasarah	2,054	2,191	2,439	2,716	3,025	3,368
		Sena'ar	864	922	1,026	1,143	1,272	1,417
		Merjam	1,368	1,459	1,625	1,809	2,014	2,243
		Asiem	598	638	710	791	881	981
		Bier Eddalyeh	266	284	316	352	392	436
			<b>18,570</b>	<b>19,807</b>	<b>22,055</b>	<b>24,558</b>	<b>27,345</b>	<b>30,449</b>
Kufranjah	Kufranjah	Kufranjah	26,891	28,683	31,938	35,562	39,599	44,093
		Rajeb	2,254	2,404	2,677	2,981	3,319	3,696
		Ballas	1,609	1,716	1,911	2,128	2,369	2,638
		Safienh	1,417	1,511	1,683	1,874	2,087	2,323
		Harth	694	740	824	918	1,022	1,138
		Thagret Zebaid	339	362	403	448	499	556
		Berkeh	98	105	116	130	144	161
		Um Erramel	43	46	51	57	63	71
		Oqdeh	25	27	30	33	37	41
		Ka'b El-Malol	170	181	202	225	250	279

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
		Noabah	0	0	0	0	0	0
			33,540	35,775	39,835	44,356	49,390	54,995
<b>Governorate Total</b>			<b>146,900</b>	<b>156,687</b>	<b>174,470</b>	<b>194,271</b>	<b>216,319</b>	<b>240,869</b>

## Karak Governorate

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
Karak Qasabah	Karak	Ader	5,419	5,720	6,258	6,848	7,493	8,198
		Shehabiyyeh	4,128	4,357	4,767	5,216	5,708	6,245
		Manshiyyet Abu Hammoor	4,572	4,826	5,280	5,777	6,321	6,917
		Jadiedh	3,463	3,655	3,999	4,376	4,788	5,239
		Rakeen	3,878	4,093	4,479	4,900	5,362	5,867
		Adnaniyyeh	3,607	3,807	4,166	4,558	4,987	5,457
		Thaniyyeh	4,048	4,273	4,675	5,115	5,597	6,124
		Battier	1,724	1,820	1,991	2,179	2,384	2,608
		Ghwair	2,458	2,594	2,839	3,106	3,399	3,719
		Median	1,580	1,668	1,825	1,997	2,185	2,390
		Samra	947	1,000	1,094	1,197	1,309	1,433
		Merwed	1,888	1,993	2,180	2,386	2,610	2,856
		Bathan	343	362	396	433	474	519
		Baqea'	960	1,013	1,109	1,213	1,327	1,452
		Zahoom	3,612	3,812	4,171	4,564	4,994	5,464
		Mshairfeh	739	780	853	934	1,022	1,118
		Ainoon	266	281	307	336	368	402
		Moomia	411	434	475	519	568	622
		Wadi Ibin Hamad	131	138	151	166	181	198
		Sakka	733	774	847	926	1,013	1,109
		Rashdiyyeh	1,596	1,685	1,843	2,017	2,207	2,415
		Waseiyeh	2,374	2,506	2,742	3,000	3,282	3,592
		Ma'mooniyyeh	478	505	552	604	661	723
		Salhiyyeh	573	605	662	724	792	867
		Mahmodeyeh	468	494	540	591	647	708
		Um Rommaneh	73	77	84	92	101	110
		Azezieh	299	316	345	378	413	452
Abdaliyyeh	246	260	284	311	340	372		
Lajoon	23	24	27	29	32	35		
Qraifleh	477	503	551	603	660	722		
Houyeh	1,655	1,747	1,911	2,091	2,288	2,504		

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
		Kamnah	127	134	147	160	176	192
		Mraighah	24	25	28	30	33	36
		Zaghairiyyeh	218	230	252	275	301	330
		Barada	831	877	960	1,050	1,149	1,257
		Karak	24,741	26,114	28,573	31,264	34,208	37,430
			<b>79,110</b>	<b>83,499</b>	<b>91,363</b>	<b>99,967</b>	<b>109,381</b>	<b>119,682</b>
Mazar Janoobee	Mazar Janoobee	Mazar Janoobee	12,669	13,372	14,631	16,009	17,517	19,166
		Mo'tah	14,530	15,336	16,780	18,361	20,090	21,982
		Tayybeh	6,114	6,453	7,061	7,726	8,454	9,250
		That Ras	3,516	3,711	4,061	4,443	4,861	5,319
		Mhiyy	3,766	3,975	4,349	4,759	5,207	5,697
Mazar Janoobee	Mazar Janoobee	Eraq	3,782	3,992	4,368	4,779	5,229	5,722
		Majra	806	851	931	1,018	1,114	1,219
		Sool	3,216	3,394	3,714	4,064	4,447	4,865
		Hashemiyyeh Janoobiyyeh	1,747	1,844	2,018	2,208	2,415	2,643
		Omqaq	472	498	545	596	653	714
		Aina	18	19	21	23	25	27
		Shqaira El-Gharbiyyeh	1,959	2,068	2,262	2,475	2,709	2,964
		Shqaira El-Sharqiyyeh	157	166	181	198	217	238
		Shariefeh	0	0	0	0	0	0
		Dabbeh	145	153	167	183	200	219
		Hartheyyeh	537	567	620	679	742	812
		Esrarah	0	0	0	0	0	0
		Ejhara	442	467	510	559	611	669
		Baqi'e Srasah	0	0	0	0	0	0
		Um El-Yanabi'e	13	14	15	16	18	20
		Hamediyeh	276	291	319	349	382	418
		Um El-Khanazeer	0	0	0	0	0	0
		Khokha	5	5	6	6	7	8
		Jozeh	132	139	152	167	183	200
		Hadbbeh	198	209	229	250	274	300
Isawaiyyeh	73	77	84	92	101	110		
Um El-Ghozlan	931	983	1,075	1,176	1,287	1,408		
Jwair	153	161	177	193	212	231		

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
		Manshiyyet EL-Mazar	957	1,010	1,105	1,209	1,323	1,448
		Dabbakeh	95	100	110	120	131	144
		No'aymeh	636	671	735	804	879	962
		Dahriyyeh	195	206	225	246	270	295
		Talbiyyeh	226	239	261	286	312	342
		Mjaidel	184	194	212	233	254	278
			<b>57,950</b>	<b>61,165</b>	<b>66,926</b>	<b>73,228</b>	<b>80,124</b>	<b>87,670</b>
Mazar Janoobe	Mo'aab	Husseiniyyeh	4,503	4,753	5,200	5,690	6,226	6,812
		Um Hamat	2,165	2,285	2,500	2,736	2,993	3,275
		Omariyyeh	2,092	2,208	2,416	2,644	2,892	3,165
		Khaldiyyeh	1,485	1,567	1,715	1,877	2,053	2,247
		Faisaliyyeh	1,555	1,641	1,796	1,965	2,150	2,352
		Kaderiyyeh	20	21	23	25	28	30
			<b>11,820</b>	<b>12,476</b>	<b>13,651</b>	<b>14,936</b>	<b>16,343</b>	<b>17,882</b>
Qasr	Qasr	Qasr	5,424	5,725	6,264	6,854	7,499	8,206
		Rabbah	5,582	5,892	6,447	7,054	7,718	8,445
		Smakiyyeh	1,888	1,993	2,180	2,386	2,610	2,856
		Yaroot	1,730	1,826	1,998	2,186	2,392	2,617
		Demnah	1,596	1,685	1,843	2,017	2,207	2,415
		Hmood	486	513	561	614	672	735
Qasr	Qasr	Sheehan	699	738	807	883	966	1,057
		Rawdah	733	774	847	926	1,013	1,109
		Rashadeih	212	224	245	268	293	321
			<b>18,350</b>	<b>19,368</b>	<b>21,192</b>	<b>23,188</b>	<b>25,372</b>	<b>27,761</b>
Qasr	Mowjeb	Mghayyer	1,250	1,319	1,444	1,580	1,728	1,891
		Riha	648	684	748	819	896	980
		Mes'ar	567	598	655	716	784	858
		Abu Trabah	422	445	487	533	583	638
		Jada'	3,318	3,502	3,832	4,193	4,588	5,020
		Mowjeb	212	224	245	268	293	321
		Alyeh	683	721	789	863	944	1,033
			<b>7,100</b>	<b>7,494</b>	<b>8,200</b>	<b>8,972</b>	<b>9,817</b>	<b>10,741</b>
Aghwar Janoobyah	Safi	Ghawr Safi	20,435	21,569	23,600	25,823	28,254	30,915
		Ghawr Faifa	2,049	2,163	2,366	2,589	2,833	3,100

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
		Mamorah	905	955	1,045	1,144	1,251	1,369
		Salmani	21	22	24	27	29	32
		Gwiebeh	620	654	716	783	857	938
			<b>24,030</b>	<b>25,363</b>	<b>27,752</b>	<b>30,365</b>	<b>33,225</b>	<b>36,354</b>
Aghwar Janoobyah	Ghawr Almazra'a	Ghawr Almazra'a	8,423	8,890	9,728	10,644	11,646	12,743
		Ghawr Hadiethah	4,413	4,658	5,097	5,576	6,102	6,676
		Ghawr Dra'	2,414	2,548	2,788	3,050	3,338	3,652
		Ghawr Assal	173	183	200	219	239	262
		Blaidet Almazra'a	110	116	127	139	152	166
		Blaidet Hadiethah	17	18	20	21	24	26
			<b>15,550</b>	<b>16,413</b>	<b>17,958</b>	<b>19,650</b>	<b>21,500</b>	<b>23,525</b>
Ayy	Ayy	Ayy	5,837	6,161	6,741	7,376	8,071	8,831
		Kathrabba	3,707	3,913	4,281	4,684	5,125	5,608
		Joza	2,306	2,434	2,663	2,914	3,188	3,489
			<b>11,850</b>	<b>12,507</b>	<b>13,685</b>	<b>14,974</b>	<b>16,384</b>	<b>17,927</b>
Faqo'e	Faqo'e	Faqo'e	5,984	6,316	6,911	7,562	8,274	9,053
		Serfa	4,902	5,174	5,661	6,194	6,778	7,416
		Emra'	2,326	2,455	2,686	2,939	3,216	3,519
		Zahra'	1,209	1,276	1,396	1,528	1,672	1,829
		Shahtoor	199	210	230	251	275	301
		Majdoleen	240	253	277	303	332	363
			<b>14,860</b>	<b>15,685</b>	<b>17,162</b>	<b>18,778</b>	<b>20,546</b>	<b>22,481</b>
Qatraneh	Qatraneh	Qatraneh	5,667	5,981	6,545	7,161	7,835	8,573
		Sad El-Soltani	2,192	2,314	2,532	2,770	3,031	3,316
		Wadi Abyadh	621	655	717	785	859	939
			<b>8,480</b>	<b>8,951</b>	<b>9,793</b>	<b>10,716</b>	<b>11,725</b>	<b>12,829</b>
<b>Governorate Total</b>			<b>249,100</b>	<b>262,921</b>	<b>287,682</b>	<b>314,774</b>	<b>344,417</b>	<b>376,853</b>

## Tafileh Governorate

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
Tafila Qasabah	Tafila	Ain El-Baidha	9854	10558	11845	13288	14908	16725
		Ies	5003	5360	6014	6747	7569	8491
		Aimeh	2694	2886	3238	3633	4076	4572
		Sanfahah	705	755	847	951	1067	1197
		Namteh	76	81	91	102	115	129
		Abu Banna	938	1005	1127	1265	1419	1592
		Shaidham	601	644	722	810	909	1020
		Erhab	660	707	793	890	998	1120
		Dhba'ah	88	94	106	119	133	149
		Majadel	467	500	561	630	707	793
		Swaimie'	449	481	540	605	679	762
		Afra	7	8	8	9	11	12
		Aboor	19	20	23	26	29	32
		Tal'et Hussain	233	250	280	314	352	395
		Barbietah	7	8	8	9	11	12
		L'iban	6	6	7	8	9	10
		Harier	2	2	2	3	3	3
		Ezhaigah	69	74	83	93	104	117
		Zabdah	6	6	7	8	9	10
		Sirah	51	55	61	69	77	87
		Jeser El-Shohada'	11	12	13	15	17	19
		Nokhah	81	87	97	109	123	137
		Arafah	1290	1382	1551	1740	1952	2189
		Abel	800	857	962	1079	1210	1358
		Sel'e	11	12	13	15	17	19
		Mitan	0	0	0	0	0	0
		Erwayye m	2066	2214	2483	2786	3126	3506
Badou El-Tafila	1572	1684	1890	2120	2378	2668		
Tafila	27924	29919	33565	37656	42245	47394		
		<b>55690</b>	<b>59668</b>	<b>66940</b>	<b>75099</b>	<b>84251</b>	<b>94519</b>	
Bsaira	Bsaira	Bsaira	8170	8754	9820	11017	12360	13866
		Qhadesiy eh	8237	8825	9901	11108	12461	13980
		Gharandal	4743	5082	5701	6396	7175	8050
		Rashadiyeh	1076	1153	1293	1451	1628	1826
		Um Essarab	596	639	716	804	902	1012

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
		Dhana	97	104	117	131	147	165
		Lahdhah	36	39	43	49	54	61
		Qarqoor	0	0	0	0	0	0
		Dhahel	25	27	30	34	38	42
			<b>22980</b>	<b>24622</b>	<b>27622</b>	<b>30989</b>	<b>34765</b>	<b>39002</b>
Hasa	Hasa	Hasa	9264	9926	11135	12493	14015	15723
		Jorof	1454	1558	1748	1961	2200	2468
		Aliah	12	13	14	16	18	20
			<b>10730</b>	<b>11497</b>	<b>12898</b>	<b>14470</b>	<b>16233</b>	<b>18211</b>
<b>Governorate Total</b>			<b>89400</b>	<b>95786</b>	<b>107460</b>	<b>120557</b>	<b>135249</b>	<b>151733</b>

### Ma'an Governorate

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
Ma'an Qasabah	Ma'an	Dabit El-Karam	73	78	87	97	108	121
		Tahooneh	58	62	69	77	86	96
		Mahatet Jerdaneh	0	0	0	0	0	0
		Sateh Ma'an	135	144	161	180	201	224
		Ma'an	34,074	36,399	40,631	45,356	50,630	56,517
			<b>34,340</b>	<b>36,683</b>	<b>40,948</b>	<b>45,710</b>	<b>51,025</b>	<b>56,958</b>
Ma'an Qasabah	Iel	Iel	1,226	1,310	1,462	1,632	1,822	2,033
		Raudet El-Amir Rashed(Qa')	2,366	2,527	2,821	3,149	3,516	3,924
		Basta	1,920	2,051	2,289	2,556	2,853	3,185
		Fardakh	1,516	1,619	1,808	2,018	2,253	2,515
		Auhadah	642	686	766	855	954	1,065
		Beir Abu Dnneh	926	989	1,104	1,233	1,376	1,536
		Sadafeh	721	770	860	960	1,071	1,196
		Beir El-Bietar	93	99	111	124	138	154
			<b>9,410</b>	<b>10,052</b>	<b>11,221</b>	<b>12,526</b>	<b>13,982</b>	<b>15,608</b>
Ma'an Qasabah	Jafr	Jafr	6,743	7,203	8,041	8,976	10,019	11,184
		Modawwarah	1,725	1,843	2,057	2,296	2,563	2,861
		Shadeiah	259	277	309	345	385	430
		Batn El-Ghool	3	3	4	4	4	5
			<b>8,730</b>	<b>9,326</b>	<b>10,410</b>	<b>11,620</b>	<b>12,972</b>	<b>14,480</b>
Ma'an Qasabah	Mraighah	Mraighah	3,151	3,366	3,757	4,194	4,682	5,226
		Naqab	486	519	580	647	722	806
		Qurain	1,224	1,308	1,460	1,629	1,819	2,030
		Abu El-Lissan	1,166	1,246	1,390	1,552	1,733	1,934
		Swaimreh	706	754	842	940	1,049	1,171
		Tasan	577	616	688	768	857	957
		Qasemeah	416	444	496	554	618	690
		Thugra	183	195	218	244	272	304

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
		Faisaleah	495	529	590	659	736	821
		Naqab El-Gharbi	13	14	16	17	19	22
		Ha'ad	63	67	75	84	94	104
			<b>8,480</b>	<b>9,059</b>	<b>10,112</b>	<b>11,288</b>	<b>12,600</b>	<b>14,065</b>
Ma'an Qasabah	Athroh	Athroh	1,210	1,293	1,443	1,611	1,798	2,007
		Manshiyyeh	2,179	2,328	2,598	2,900	3,238	3,614
		Jarba Kbiereh	571	610	681	760	848	947
		Mohammadiyyeh	315	336	376	419	468	522
		Etmaiyah	102	109	122	136	152	169
		Jarba Sghiereh	229	245	273	305	340	380
		Bair Abu El-A	80	85	95	106	119	133
		Ashari	64	68	76	85	95	106
			<b>4,750</b>	<b>5,074</b>	<b>5,664</b>	<b>6,323</b>	<b>7,058</b>	<b>7,879</b>
Petra	Petra	Wadi Moosa	18,243	19,488	21,754	24,283	27,107	30,259
		Taybah	6,107	6,524	7,282	8,129	9,074	10,129
		Rajef	1,788	1,910	2,132	2,380	2,657	2,966
		Petra	0	0	0	0	0	0
		Dlaghah	1,532	1,637	1,827	2,039	2,276	2,541
		Um Sehoon	1,742	1,861	2,077	2,319	2,588	2,889
		Baida	428	457	510	570	636	710
		Hayy	0	0	0	0	0	0
		Madarej	153	163	182	204	227	254
		Ain Ammoon	296	316	353	394	440	491
		Tharwah	122	130	145	162	181	202
		Rassees	276	295	329	367	410	458
		Kerbet Um Ettelian	23	25	27	31	34	38
					<b>30,710</b>	<b>32,805</b>	<b>36,620</b>	<b>40,878</b>
Shobak	Shobak	Shobak	2,631	2,811	3,137	3,502	3,909	4,364
		Zobeiriyyeh	1,072	1,145	1,278	1,427	1,593	1,778
		Mothallath	1,768	1,889	2,108	2,353	2,627	2,932



### Aqaba Governorate

District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
Aqaba Qasabah	Aqaba	Mezfer	164	178	204	233	267	305
		Teten	19	21	24	27	31	35
		Track Area	611	663	758	868	993	1,137
		Re'a Sa'adeh	19	21	24	27	31	35
		Kaldi	187	203	232	266	304	348
		Aqaba	109,150	118,359	135,466	155,046	177,456	203,105
			<b>110,150</b>	<b>119,443</b>	<b>136,707</b>	<b>156,467</b>	<b>179,082</b>	<b>204,966</b>
Aqaba Qasabah	Wadi Araba	Reisheh	1,667	1,808	2,069	2,368	2,710	3,102
		Qraiqreh	1,391	1,508	1,726	1,976	2,261	2,588
		Rahmah	1,397	1,515	1,734	1,984	2,271	2,600
		Beir Mathkooor	470	510	583	668	764	875
		Qatar	226	245	280	321	367	421
		Fienan	414	449	514	588	673	770
		Gharandal	0	0	0	0	0	0
		Badou Abu Khushibeh	125	136	155	178	203	233
			<b>5,690</b>	<b>6,170</b>	<b>7,062</b>	<b>8,083</b>	<b>9,251</b>	<b>10,588</b>
Quairah	Quairah	Quairah	10,060	10,909	12,485	14,290	16,356	18,720
		Rashdyah	2,511	2,723	3,116	3,567	4,082	4,672
		Rum	1,567	1,699	1,945	2,226	2,548	2,916
		Hmaimieh Jadiedeh	1,212	1,314	1,504	1,722	1,970	2,255
		Dabbet Hanoot	1,219	1,322	1,513	1,732	1,982	2,268
		Shakriyyeh	310	336	385	440	504	577
		Sallheiah	262	284	325	372	426	488
		Asaleah	307	333	381	436	499	571
		Hmaimieh	494	536	613	702	803	919
		Um El-Bsateen	128	139	159	182	208	238
					<b>18,070</b>	<b>19,595</b>	<b>22,427</b>	<b>25,668</b>
Quairah	Diesah	Diesah	2,086	2,262	2,589	2,963	3,391	3,882

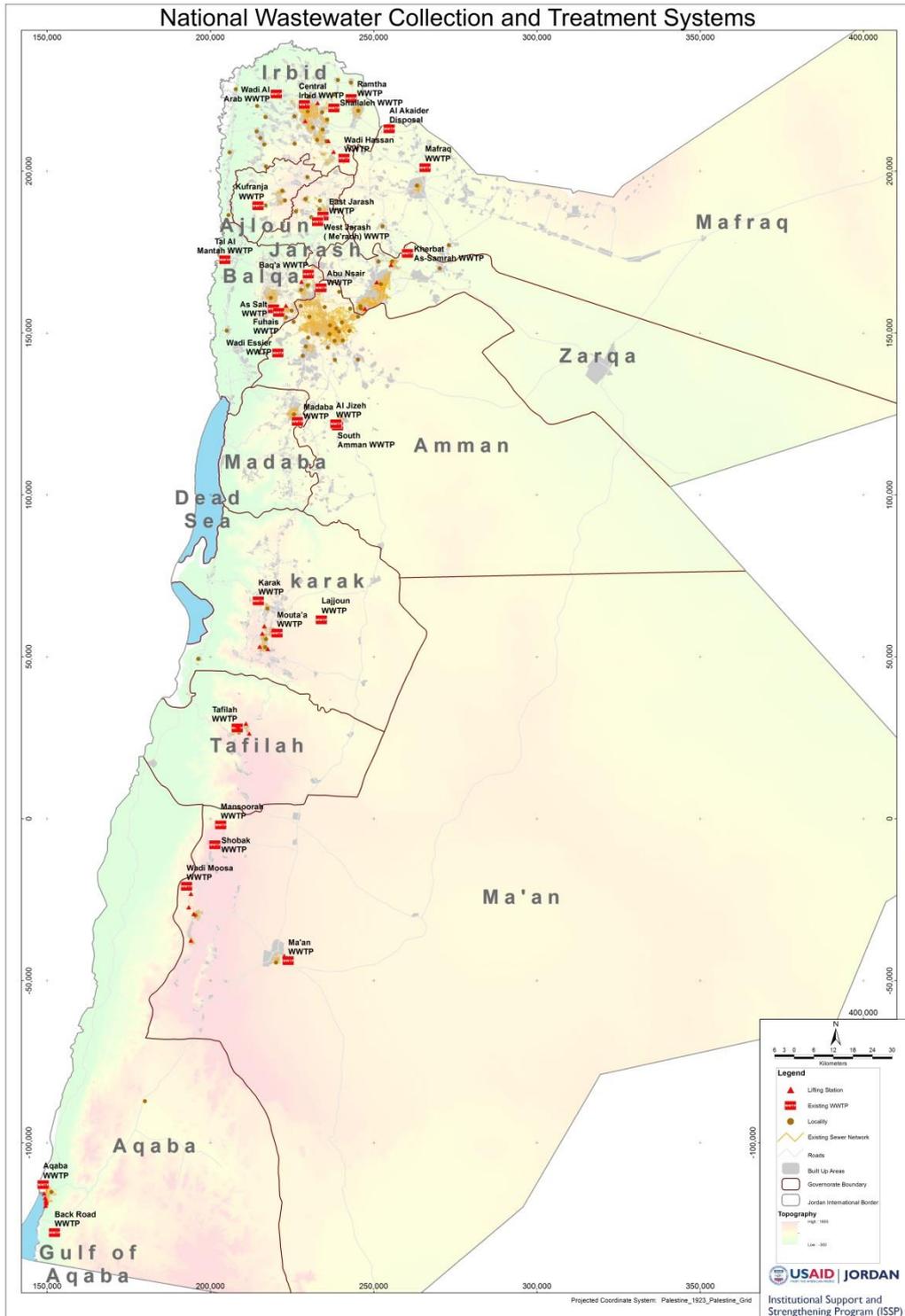
District	Sub-District	Locality	Population 2012	Population 2015	Population 2020	Population 2025	Population 2030	Population 2035
		Twaisch	1,588	1,722	1,971	2,256	2,582	2,955
		Mnaishier	620	672	769	881	1,008	1,154
		Taweel	672	729	834	955	1,093	1,250
		Ghal	324	351	402	460	527	603
			<b>5,290</b>	<b>5,736</b>	<b>6,565</b>	<b>7,514</b>	<b>8,600</b>	<b>9,844</b>
<b>Governorate Total</b>			<b>139,200</b>	<b>150,944</b>	<b>172,761</b>	<b>197,732</b>	<b>226,311</b>	<b>259,022</b>

## ANNEX 2 - WASTEWATER TREATMENT PLANTS IN JORDAN

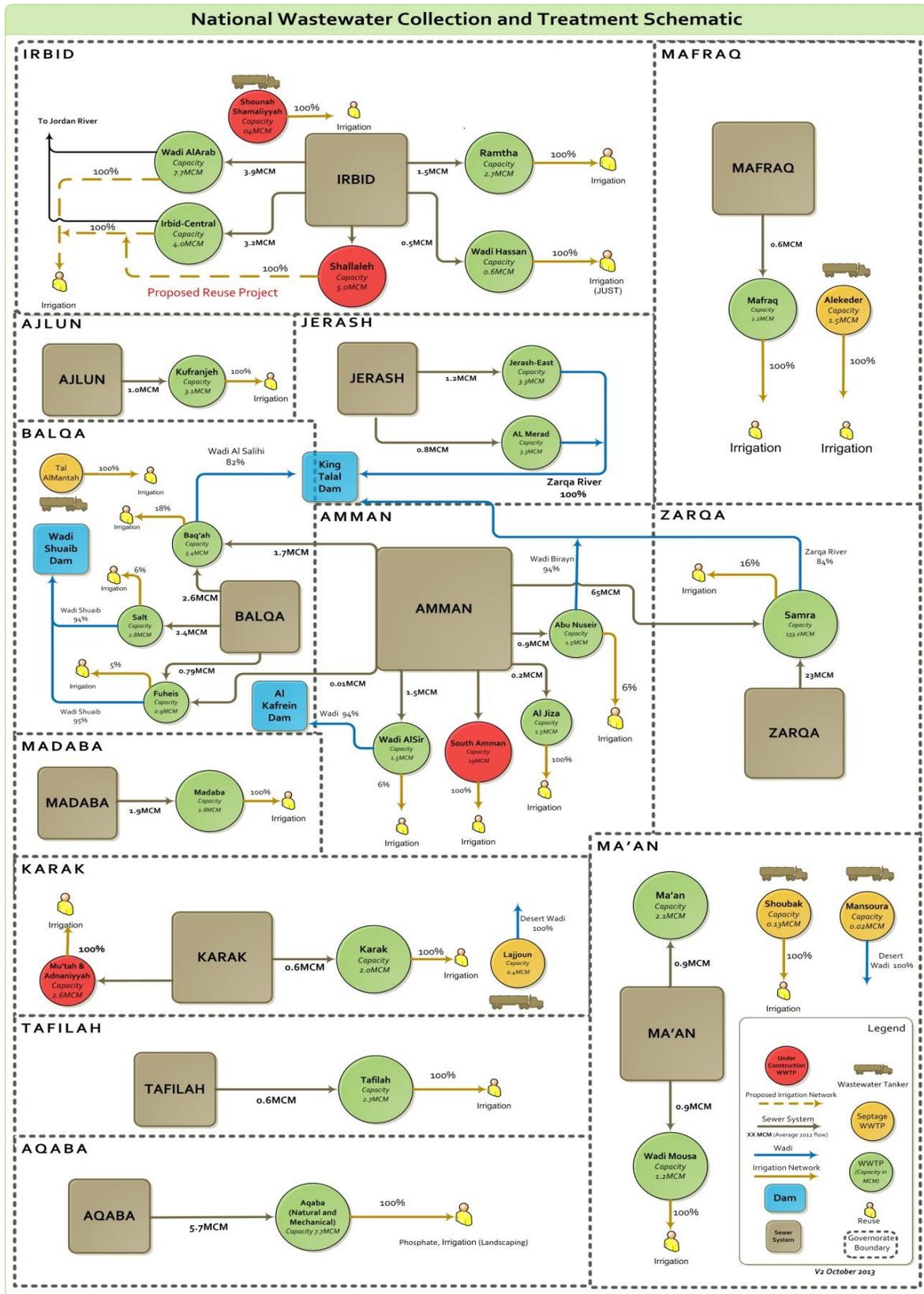
No.	WWTP NAME	YEAR OF OPERATION	YEAR OF UPDATE	TECHNOLOGY	Service Governorate	Design Capacity after upgrade (people)	Calculated Connected Population (Based on actual BOD loads) (people)	AV. DESIGN flow m3/d	AV. ACTUAL flow m3/d	AV. DESIGN BOD LOAD kg/d	AV. ACTUAL BOD LOAD kg/d
1	Aqaba - Natural	1987		Waste Stab Ponds	Aqaba	124,615	40,210	9,000	7,220	8,100	2,614
2	Aqaba - Mechanical	2005		Extended Aeration	Aqaba	77,538	46,614	12,000	8,511	5,040	3,030
3	Baqa	1987	1998	Trickling Filter (TF)	Amman, Balqa	183,385	110,102	14,900	11,713	11,920	7,157
4	Fuheis	1997		Activated Sludge	Amman, Balqa	36,738	18,830	2,400	2,305	2,388	1,224
5	Irbid - Central	1987		TF & Activ Sludge	Irbid	135,668	127,267	11,023	8,635	8,818	8,272
6	Jerash-East	1983	Committed	Oxidation Ditch	Jerash	152,308	65,327	9,000	3,333	9,900	4,246
7	Karak	1988	Committed	Trickling Filter (TF)	Karak	59,231	27,000	5,500	1,753	3,850	-
8	Kufranja	1989	Under Construction	Trickling Filter (TF)	Ajloun	96,923	28,523	9,000	2,763	6,300	1,854
9	Madaba	1989	2003	Activated Sludge	Madaba	111,077	92,495	7,600	5,260	7,220	6,012
10	Mafraq	1988	Under Construction	Waste Stab Ponds	Mafraq	76,788	-	6,050	1,618	4,991	-
11	Ma'an	1989	2008	Extended Aeration	Ma'an	62,160	14,184	5,772	2,358	4,040	922
12	Abu Nuseir	1986		Active Sludge R,B,C	Amman	67,692	26,965	4,000	2,401	4,400	1,753
13	Ramtha	1987	2005	Activated Sludge	Irbid	83,077	55,329	5,400	4,050	5,400	3,596
14	Sult	1981	2005	Extended Aeration	Balqa	71,077	59,062	7,700	6,529	4,620	3,839
15	Tafila	1988	Committed	Trickling Filter (TF)	Tafila	83,077	15,241	7,500	1,575	5,400	991

No.	WWTP NAME	YEAR OF OPERATION	YEAR OF UPDATE	TECHNOLOGY	Service Governorate	Design Capacity after upgrade (people)	Calculated Connected Population (Based on actual BOD loads) (people)	AV. DESIGN flow m <sup>3</sup> /d	AV. ACTUAL flow m <sup>3</sup> /d	AV. DESIGN BOD LOAD kg/d	AV. ACTUAL BOD LOAD kg/d
16	Wai Al Arab	1999		Extended Aeration	Irbid	321,462	148,548	21,000	10,681	20,895	9,656
17	Wadi Hassan	2001		Oxidation Ditch	Irbid	19,692	22,436	1,600	1,238	1,280	1,458
18	Wadi Mousa	2000		Extended Aeration	Ma'an	41,846	12,095	3,400	2,536	2,720	786
19	Wadisseeer	1997		Aeration Lagoon	Amman	48,000	37,163	4,000	4,053	3,120	2,416
20	Alekedder-Tankers	2005		Waste Stab Ponds	Ma'raq	92,308	-	4,000	3,232	6,000	-
21	Lajjon-Tankers	2005	Under Construction	Waste Stab Ponds	Karak	12,923	-	1,200	735	840	-
22	Tal AlMantah-Tankers	2005		TF & Activ Sludge	Balqa	12,308	8,766	400	365	800	570
23	Al Jiza	2008		Activated Sludge	Amman	49,231	7,315	4,000	624	3,200	475
24	Samra	1984	(1)2008, (2)Under Construction	Activated Sludge	Amman, Zarqa	3,648,000	2,620,523	364,800	240,925	237,120	170,334
25	Al Merad	2010		Activated Sludge	Jerash	110,769	25,620	9,000	2,297	7,200	1,665
26	Shobak - Tankers	2010		Waste Stab Ponds	Ma'an	9,962	359	350	67	648	23
27	Mansorah - Tankers	2010		Waste Stab Ponds	Ma'an	-	-	50	13	0	0
	<b>New WWTPs</b>										
28	South Amman		Under Construction		Amman	600,000		52,000		39,000	
29	Mu'tah and Adnaniyyah		Under Construction		Karak	81,462		7,060		5,295	
30	Shallaleh		Under Construction		Irbid	160,606		13,700		10,439	
31	Shouna Shamaliyyah		Under Construction		Irbid	34,154		1,200		2,220	
	<b>Totals</b>					<b>6,694,845</b>	<b>3,609,974</b>	<b>606,605</b>	<b>336,790</b>	<b>435,165</b>	<b>232,893</b>

# ANNEX 3 - NATIONAL WASTEWATER COLLECTION & TREATMENT SYSTEMS MAP



## National Wastewater Collection & Treatment Schematic



# **ANNEX 4 - STUDY ON GROUNDWATER RESOURCES PROTECTION PRIORITIES**

## **Introduction**

More than 60% of the total fresh water use in Jordan is covered by groundwater exploitation in twelve main groundwater basins.

Among the twelve basins, Amman Zarqa, Azraq, Yarmouk, Dead Sea, Jordan valley and Disi are storing more than 80% of the fresh groundwater stocks in the country (see figure V-1)

According to the continuous population growth and successive migration events, more measures are needed to protect the limited water resources. With a growing demand for fresh water and high production of wastewater the vulnerable basins are endangered qualitatively.

In order to protect the available groundwater stocks especially in the vulnerable basins, wastewater treatment is highly requested.

## **Basin Vulnerability**

The core and concept of groundwater vulnerability is based on the natural protection of the aquifer by confining units, land use and geology (Vrba & Zaporozec, 1994).

Mapping of groundwater vulnerability is an important tool to draw the attention of land use planners to existing problems. It is also used to anticipate the transfer of pollutants in the soil and unsaturated zone, allowing decision makers to modify the potential occurrence of harmful conditions, such as groundwater contamination, before serious impacts occur (Murray and Rogers, 1999).

## **Vulnerability Modeling**

DRASTIC model is one of the important vulnerability models. Within this model, spatial datasets are combined with regards to: Depth to groundwater, Recharge by rainfall, Aquifer type, Soil properties, Topography, Impact of the vadose zone and the hydraulic Conductivity of the aquifer (Engel et al., 1996).

On the scale of Jordan Vulnerability mapping cannot be achieved easily as the needed time to achieve this assignment for the whole country needs a three to four years project.

In order to prioritize the administrative areas according to the urgency of waste water treatment services a modified procedure was thus followed in this work.

The key players for aquifer vulnerability proved to be:

- Depth to the groundwater.
- Geology and aquifer media
- Soil cover.
- Wadis and high permeability wadi beds.

In addition to the previously mentioned parameters the available water supply systems (wells, springs and reservoirs) were considered as areas needing protection.

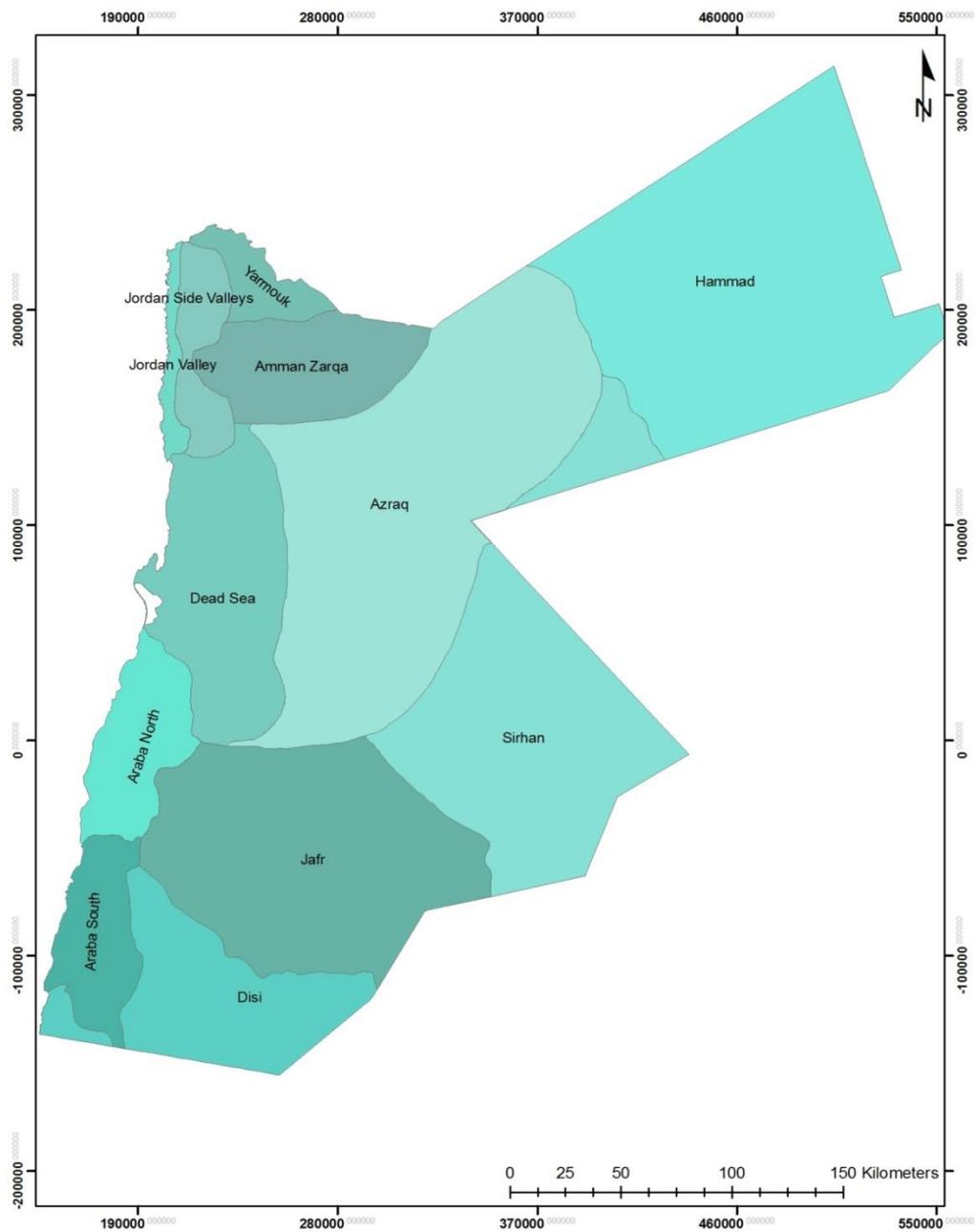


Figure V-1: Groundwater basins in Jordan

### **Depth to groundwater:**

Groundwater depth is the main factor in aquifer vulnerability as it defines the travel distance of pollutants from the top soil to the groundwater system. Shallow water levels are the most vulnerable to contamination due to the quick transfer of pollutants.

In order to model the spatial variation of groundwater depth, monitoring wells data was obtained from the MWI data bank as time series record.

The distribution of available groundwater monitoring wells is focused in the highland and in the main productive aquifer and cannot generate an accurate depth to water map for the whole country.

More data was obtained from the recent pumping test data (after 2000) taking in consideration a yearly drop in the groundwater level of one meter (See figure V-2 and V-3).

All of the groundwater level data were combined then classified according to aquifer type and modeled in the GIS environment and combined with a Digital Elevation Model to achieve the depth to ground water map shown in figure V-4.

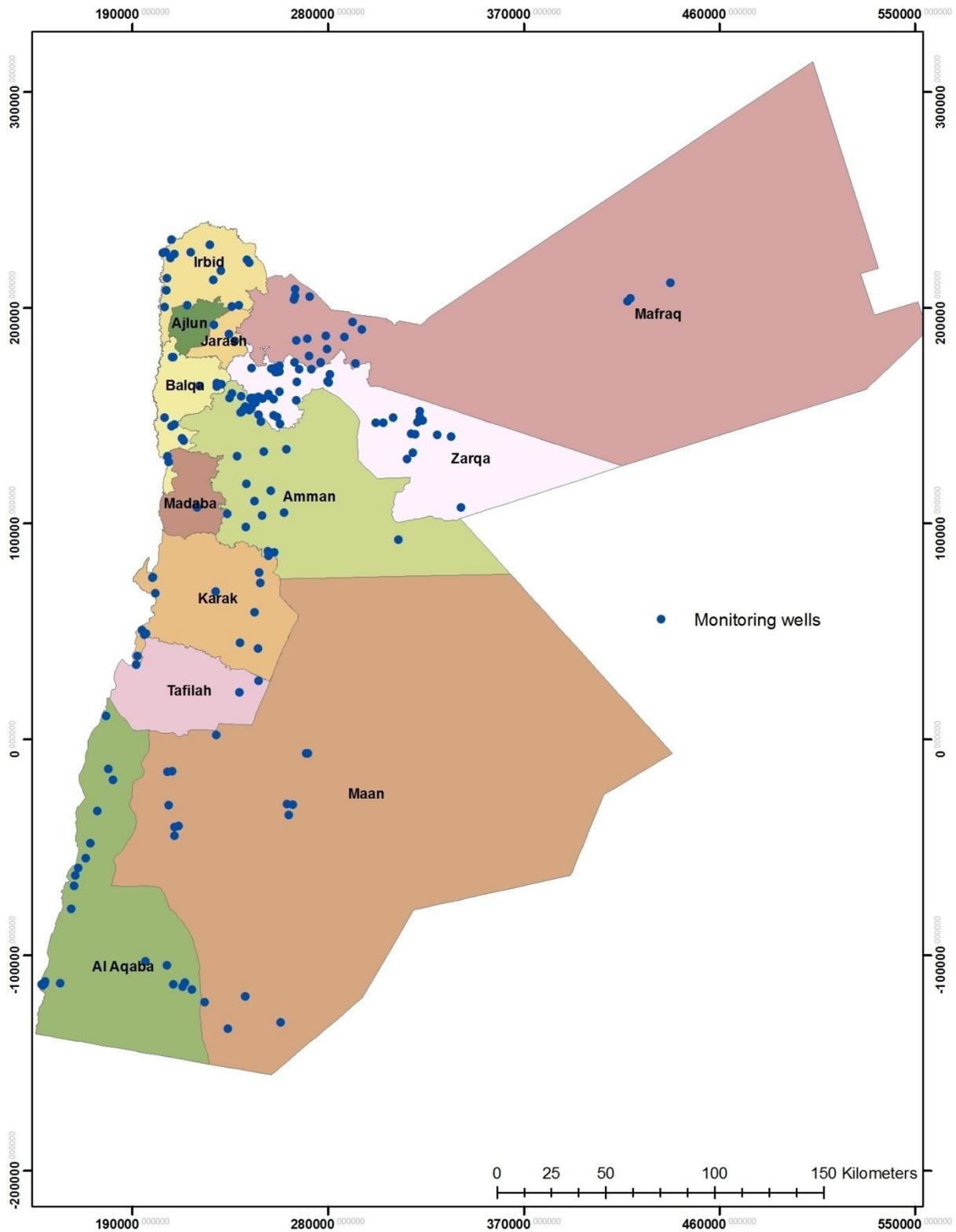


Figure V-2: Location map for groundwater monitoring wells in Jordan.

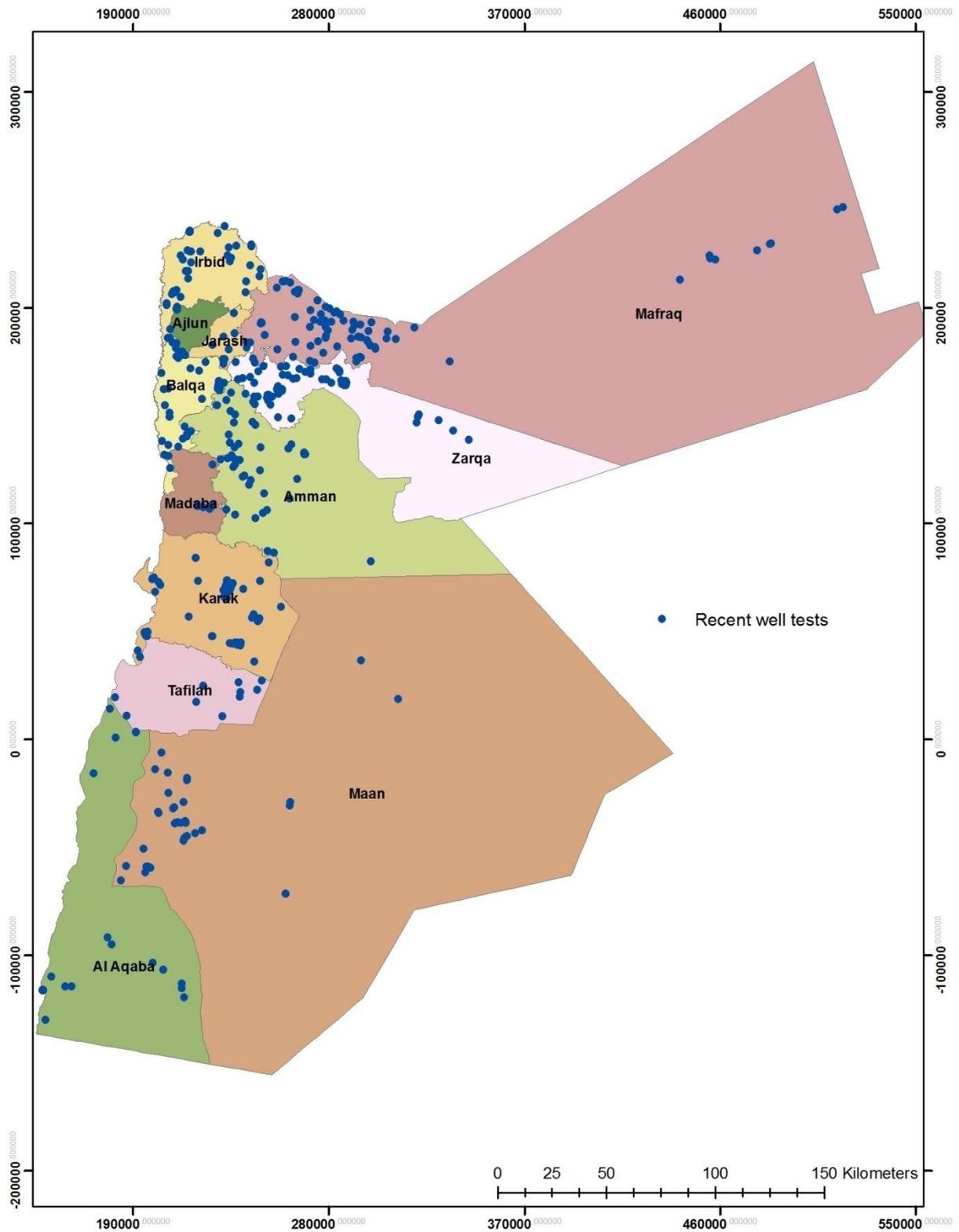


Figure V-3: Location map for recent pumping tests (after 2000).

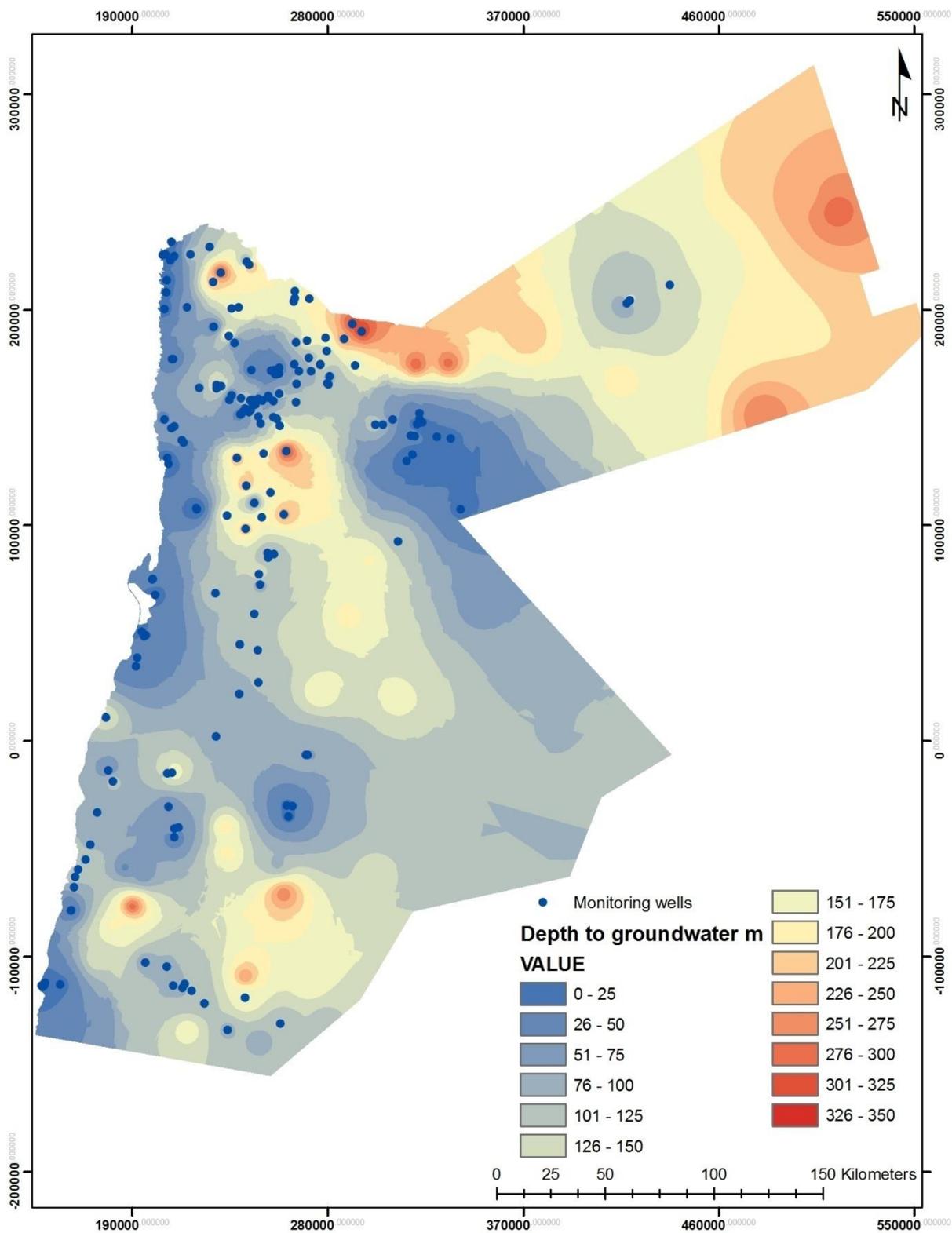


Figure V-4: Depth to the groundwater in Jordan.

## Geology and Aquifer Media

The dominant geologic formation defines the permeability of the aquifer media when the pollutants transfer through the vadose unsaturated zone.

In Jordan seven main hydrogeological units composing the underground system as shown in figure V-5.

The units vary in thickness, hydraulic characteristics, and lithology giving a high hydraulic variation ranging from high productive aquifers to the low potential aquifers as detailed in Table V-1 below.

**Table V-1: The Main Hydrogeologic Units in Jordan**

Name	Aquifer ID	Geology	Hydraulic system
<b>Alluvium</b>	Alluvium	alluvial deposits	Shallow Aquifer Systems
<b>Basement Complex</b>	BSCPX	Basalt and granite	Basaltic and granetic aquifers
<b>Rijam/Wadi Shall</b>	B4/B5	limestone, chalk, chert	Shallow Aquitard Systems
<b>Muwaqqar</b>	B3	chalky marl, marl, limestone	Shallow Aquifer Systems
<b>Amman/Wadi Sir</b>	B2/A7	limestone, dolomitic limestone	Upper Cretaceous Limestone Aquifer
<b>Lower Ajlun</b>	A6-A1	marl, limestone, dolomite	Upper Cretaceous Limestone Aquitard
<b>Kurnub</b>	K	sandstone	Deep Sandstone Hydraulic Complex Aquifer

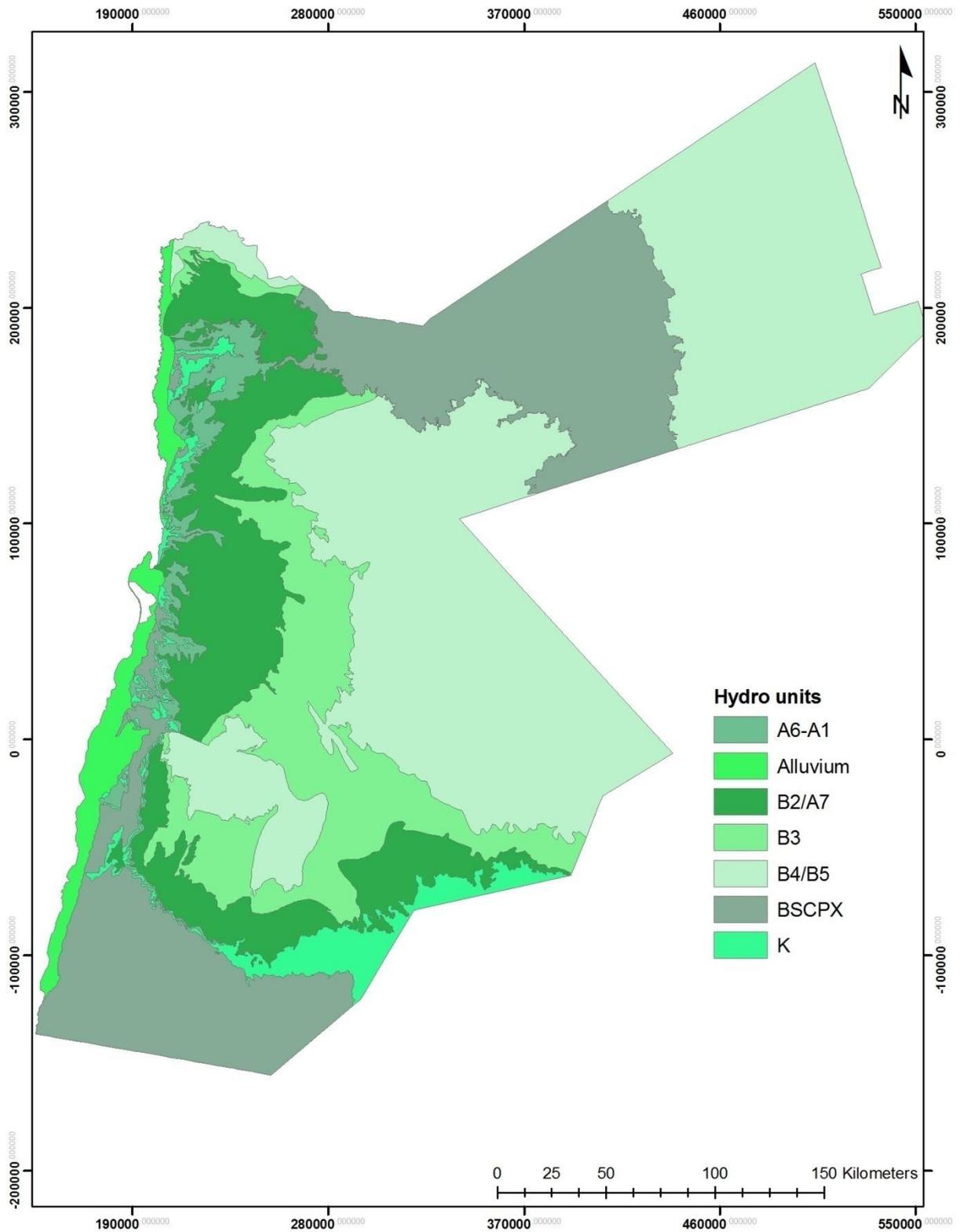


Figure V-5: Main Hydrogeological units in Jordan.

### Soil Cover:

A soil map for the whole country was obtained from the Ministry of Agriculture land use project 1996 indicating the main soil units and characteristics (see Figure V-6&Table V-2).

Soil cover represents the first groundwater protection layer and act as a filter media for contaminants transferred by water to the underground system.

The main effective soil parameters in this domain are thickness and clay content. The clay content affects strongly the permeability of the soil profile and the high thickness retards the pollutants downward and lateral movements.

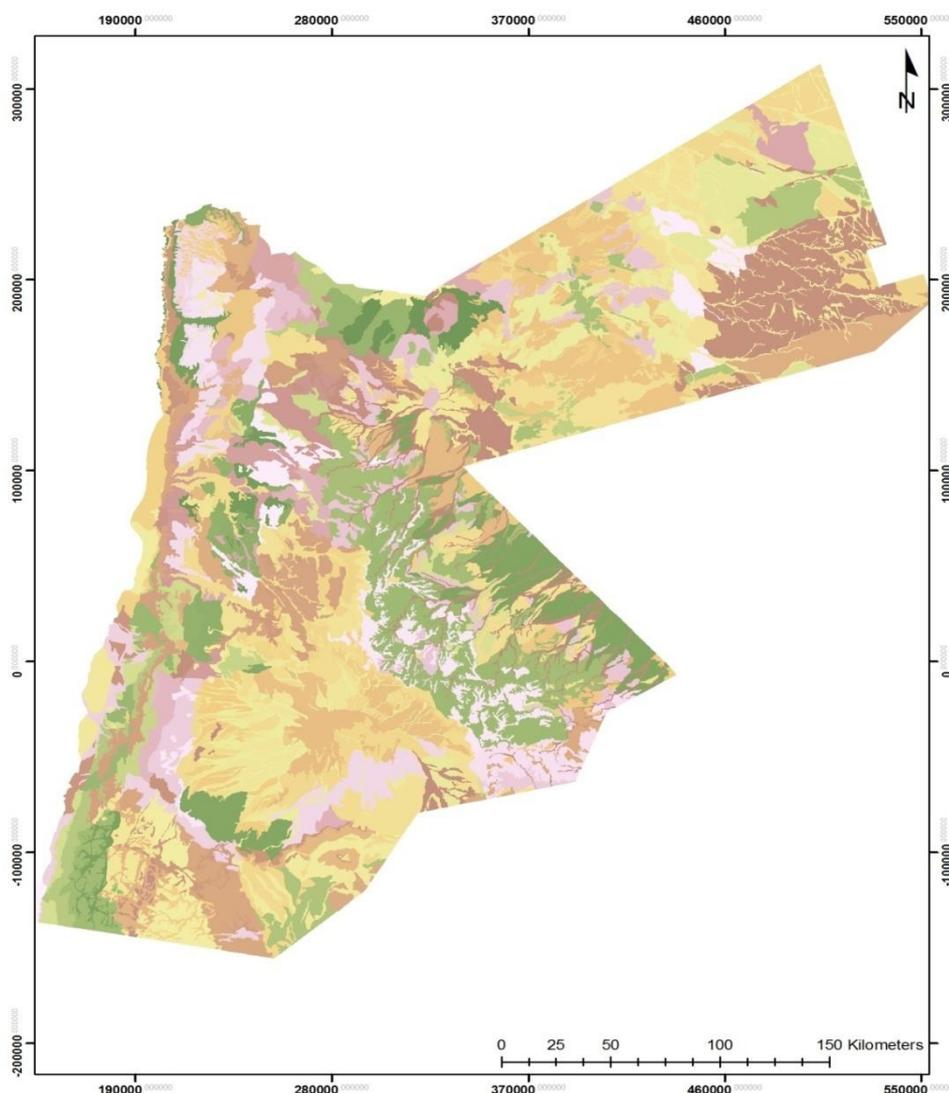


Figure V-6: Soil Map of Jordan.

**Table 2: Main Soil Units of Jordan**

Soil unit	Name	Region	Land System	Description
ALL	Tell Alluba	4	1	L1/ALL
ZAY	Uzaymi	4	2	L1/ZAY
ANJ	Anjara	8	1	L1/ANJ
JER	Jerash	8	4	L1/JER
ZAR	Zarqa	8	5	L1/ZAR
ALI	Abu Salih	8	6	L1/ALI
HAB	Rihab	8	6	L1/HAB
BAQ	Baqa'a	8	7	L1/BAQ
BAN	Hisban	8	12	L1/BAN
IRI	Tell Umeiri	8	13	L1/IRI
YAD	Yadudah	8	17	L1/YAD
BIR	Jabir	8	18	L1/BIR
NIS	Nisab	11	1	L1/NIS
GAB	Ghabawi	11	2	L1/GAB
HAL	Hallabat	11	3	L1/HAL
HAT	Qihat	11	4	L1/HAT
DEI	Mudeisis	11	5	L1/DEI
TAR	Tarmah	11	6	L1/TAR
SIS	Mudeisisat	11	8	L1/SIS
ABY	Abyad	11	9	L1/ABY
FUL	Fuluq	13	10	L1/FUL
ATT	Attarat	13	22	L1/ATT
THA	Ramtha	15	1	L1/THA
WAY	Huwaynit	15	2	L1/WAY
SAB	Sabha	15	3	L1/SAB
ZUM	Zumlat	15	4	L1/ZUM
DHU	Dhuleil	15	8	L1/DHU
AJL	Ajlun	18	1	L1/AJL
SAK	Sakhra	18	1	L1/SAK
IBB	Ibbin	18	2	L1/IBB
GAB	Ghabawi	11	2	L1/GAB
HAL	Hallabat	11	3	L1/HAL
DEI	Mudeisis	11	5	L1/DEI
TAR	Tarmah	11	6	L1/TAR
SIS	Mudeisisat	11	8	L1/SIS
ABY	Abyad	11	9	L1/ABY
BAY	Dubayn	11	12	L1/BAY
BRA	Kabra	11	14	L1/BRA
JID	Jidhan	13	5	L1/JID
AHA	Er Raha	13	7	L1/AHA
WAH	Dhirwah	13	8	L1/WAH
FUL	Fuluq	13	10	L1/FUL
YIR	Bayir	13	11	L1/YIR
ISS	Bissah	13	12	L1/ISS

Soil unit	Name	Region	Land System	Description
DUR	Duraysah	13	13	L1/DUR
QAS	Qasr Amra	13	14	L1/QAS
NAY	Sunaynirat	13	15	L1/NAY
JUL	Julayfat	13	19	L1/JUL
UFA	Sufayrat	13	21	L1/UFA
ATT	Attarat	13	22	L1/ATT
RAJ	Rajil	13	27	L1/RAJ
AZR	Azraq	13	28	L1/AZR
DUG	Dugheilal	13	30	L1/DUG
QUT	Qutteiniya	14	1	L1/QUT
HEI	Musheish	14	3	L1/HEI
WAY	Huwaynit	15	2	L1/WAY
SAB	Sabha	15	3	L1/SAB
ZUM	Zumlat	15	4	L1/ZUM
BIS	Bishriya	15	5	L1/BIS
FAR	Mafarid	15	6	L1/FAR
DHU	Dhuleil	15	8	L1/DHU
JAW	Jawa	16	1	L1/JAW
SHA	Shurafa	16	2	L1/SHA
LAN	Humaylan	16	3	L1/LAN
AWI	Safawi	16	4	L1/AWI
TFI	Qattafi	16	5	L1/TFI
NAT	Duhnath	16	6	L1/NAT
UBI	Janubi	16	7	L1/UBI

### Wadis and High Permeability Wadi Beds:

Along the drainage system accumulation of wadi bed gravel and Lacustrine sediments take place. The dominance of rounded gravel enhances the permeability of the exposed geologic formation and increases the infiltration to the groundwater system and represents a vulnerable area to pollution.

The Spread Wadis were obtained from geologic maps 1:5,000 published by NRA Geologic Survey Project and modeled as a moderately effective parameter in the priority mapping (see Figure V-7).

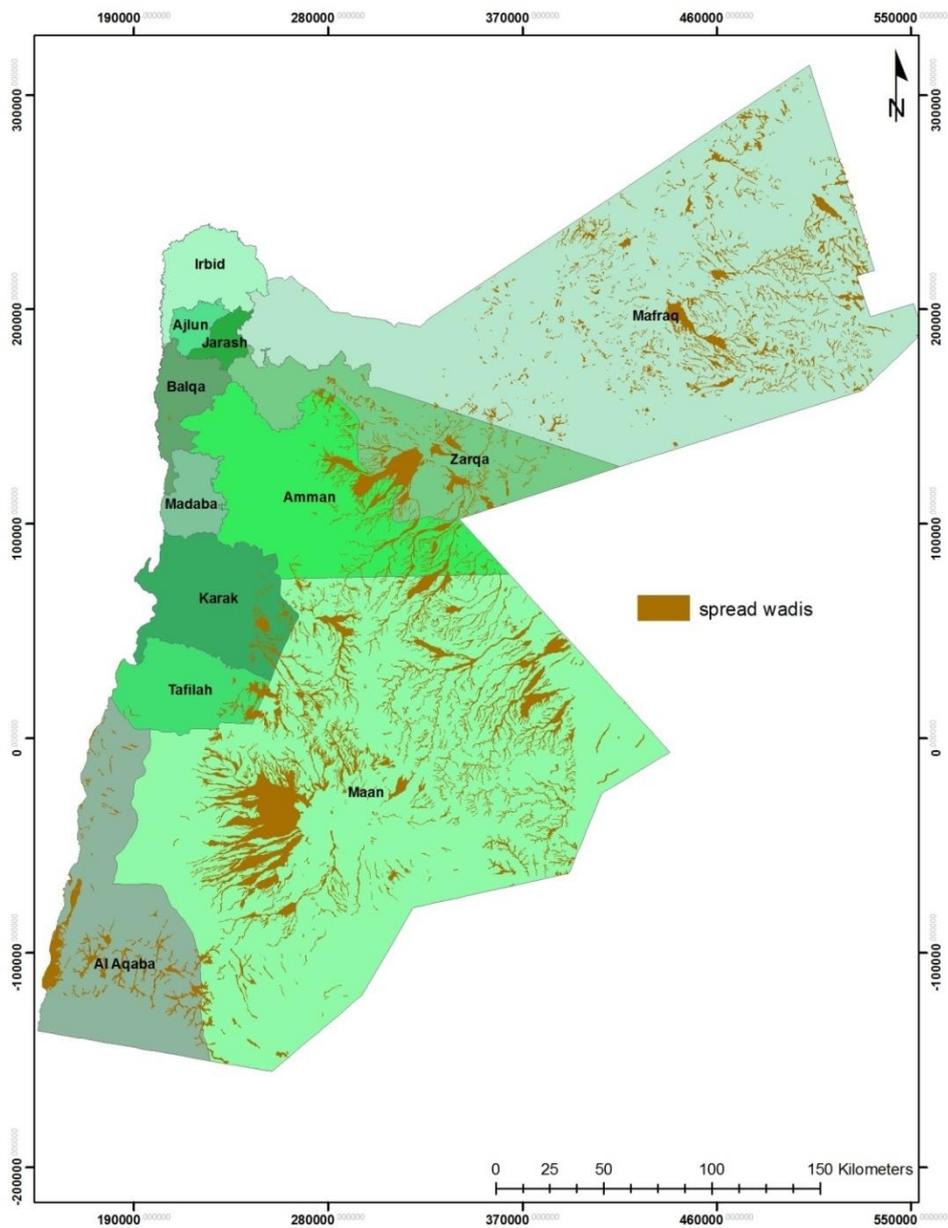


Figure V-7: Spread Wadis in Jordan.

**Water Resources:**

Groundwater regulation and legislations in Jordan consider wells and springs as protected areas with minimum activities to take place in the vicinity of those resources.

According to the files of the MWI (2013), a total of 632 productive governmental springs and wells are used for freshwater supply (See Figure V-8)

Within this prioritization of waste water services the water resources are considered of a high vulnerability and protection measures needs to be taken to prevent pollution.

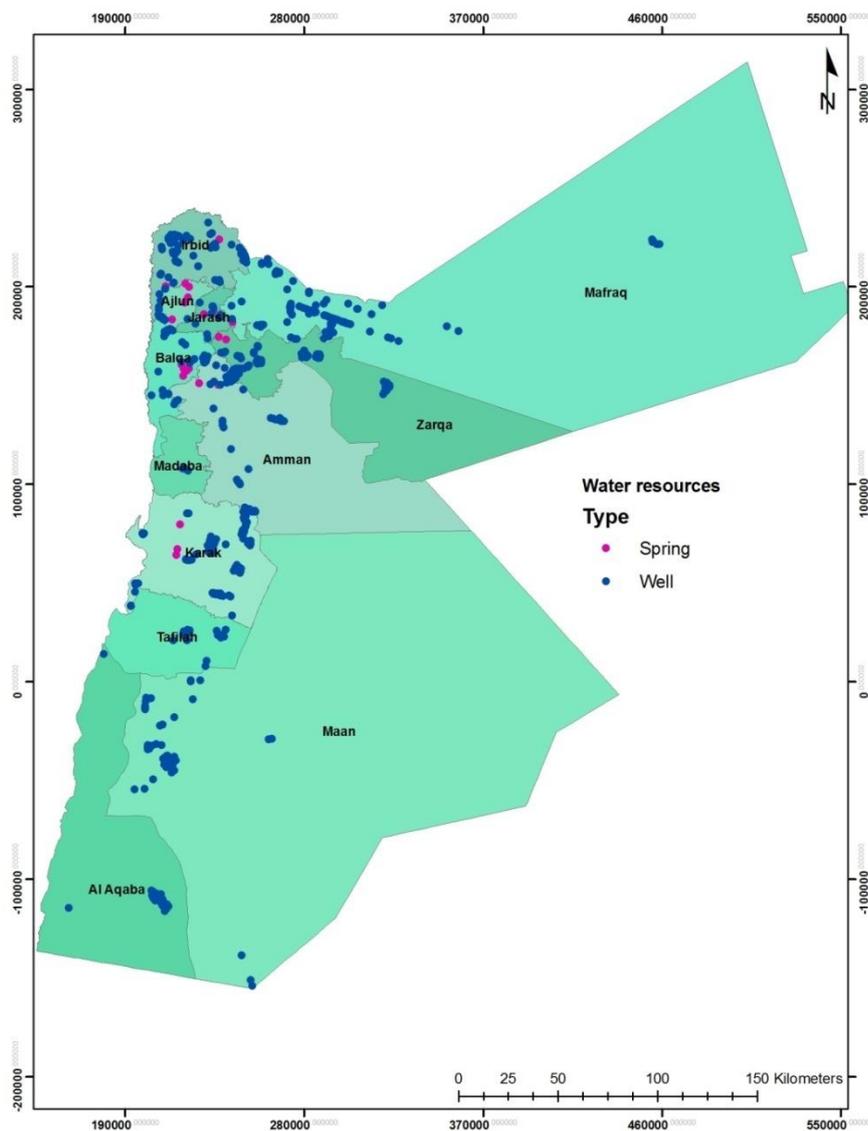


Figure V-8: Productive Wells and Springs Location Map.

## Combination of Layers and Results

All of the previous factors were georeferenced, combined and modeled in the GIS environment according to the procedure shown in Figure V-9.

The main important factor in this domain is the depth to the ground water which was modeled by reclassifying the depth to water into 50 m classes. This layer was obtained from the active monitoring data and combined with recent well test data to cover gaps in the spatial distribution. The water depth classes were rated from 100 for the shallow water level to a minimum of zero at the deep groundwater systems (more than 300 m).

The second factor within this work is the rock media which was extracted from geological maps and well drilling records. The resulting map indicated the presence or absence of aquifers that need to be protected. Areas with water holding formations were given a high rate of 30 whereas areas with no potential aquifers given a rate of zero as here will be no groundwater needs to be protected.

Following the same procedure with aquifer materials, the enhanced permeability areas were delineated to represent areas of local high permeability. The rates given to this factor varies from 10 when the permeability is enhanced to zero in where wadi gravels are not present.

The last effective layer within this scope is the soil profile which has with a very low effect due to the fact that the soil is usually removed when constructing septic tanks and/or wastewater local storage reservoirs. Soil thickness in Jordan is very limited with an average soil thickness less than 1 meter all around the country. Locally in the basins thickness may exceed 20 m, but this is limited to some areas and cannot be generalized. The soil thickness was classified into 3 main classes; shallow soil, medium depth soil and thick soil and were given rates of 10, 5 and zero respectively.

Finally the available water resources such as springs and wells were considered into the priority mapping as potential areas for pollution. A 3 kilometers buffer zone was implemented and considered as a protection area for each source to be an added value to the previous factors.

The resulted layers were combined in the GIS environment to achieve the final priority map shown in Figure V-10.

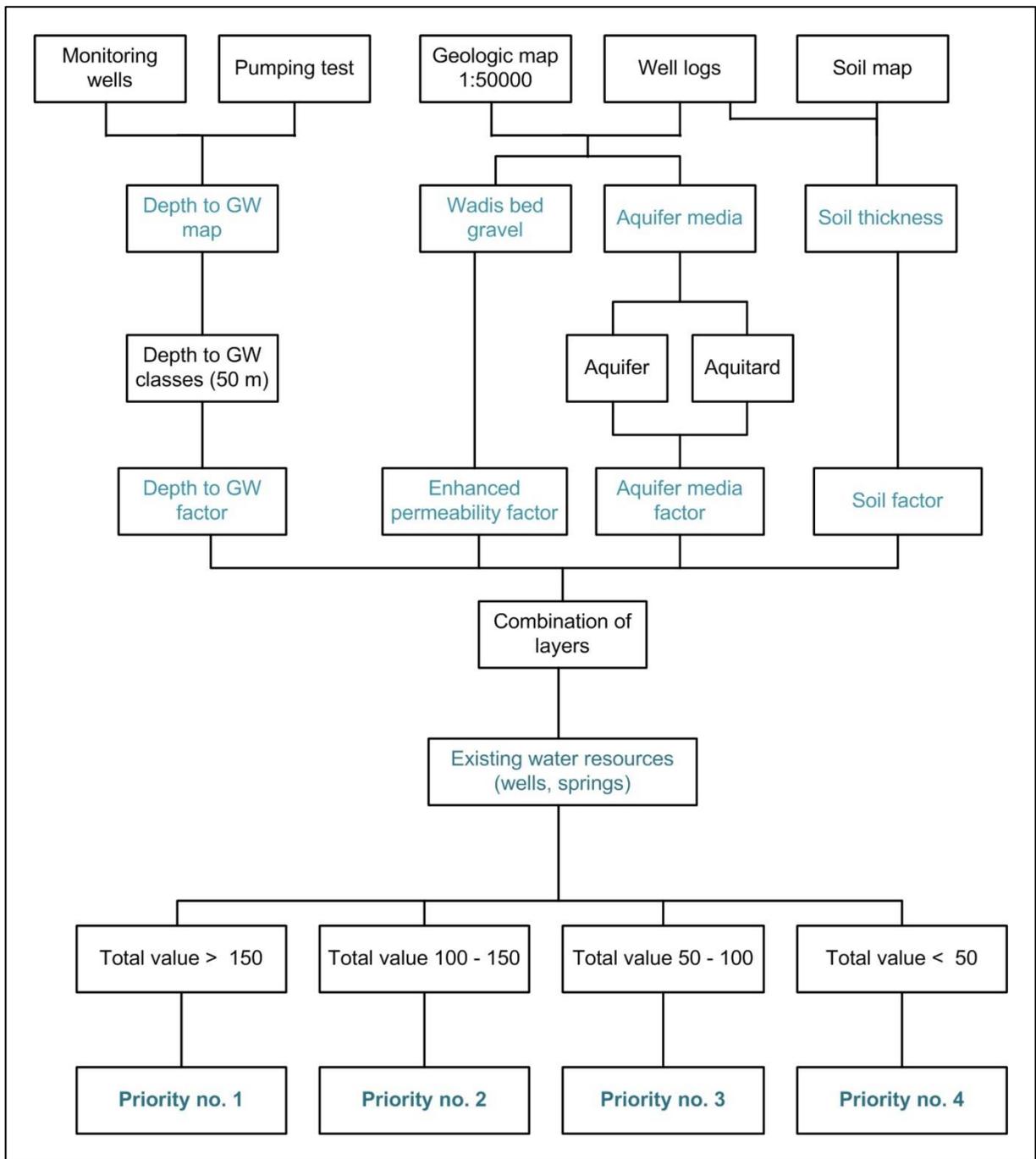


Figure V-9: General Procedure in Priority Mapping.

The modeling of the previously mentioned vulnerability parameters gave four priorities for waste water treatment based on the hydrogeologic setup of the different basins.

The resulting prioritization map is shown in Figure V-10. The map indicates a high need for waste water treatment in many areas mainly Azraq and the Jordan valley due to the shallow aquifer system and the high permeability of vadose zone composed of permeable alluvium sediments.

According to the model results, the priority no. 1 is to be implemented on a short term bases due to the urgent need of waste water services in such areas.

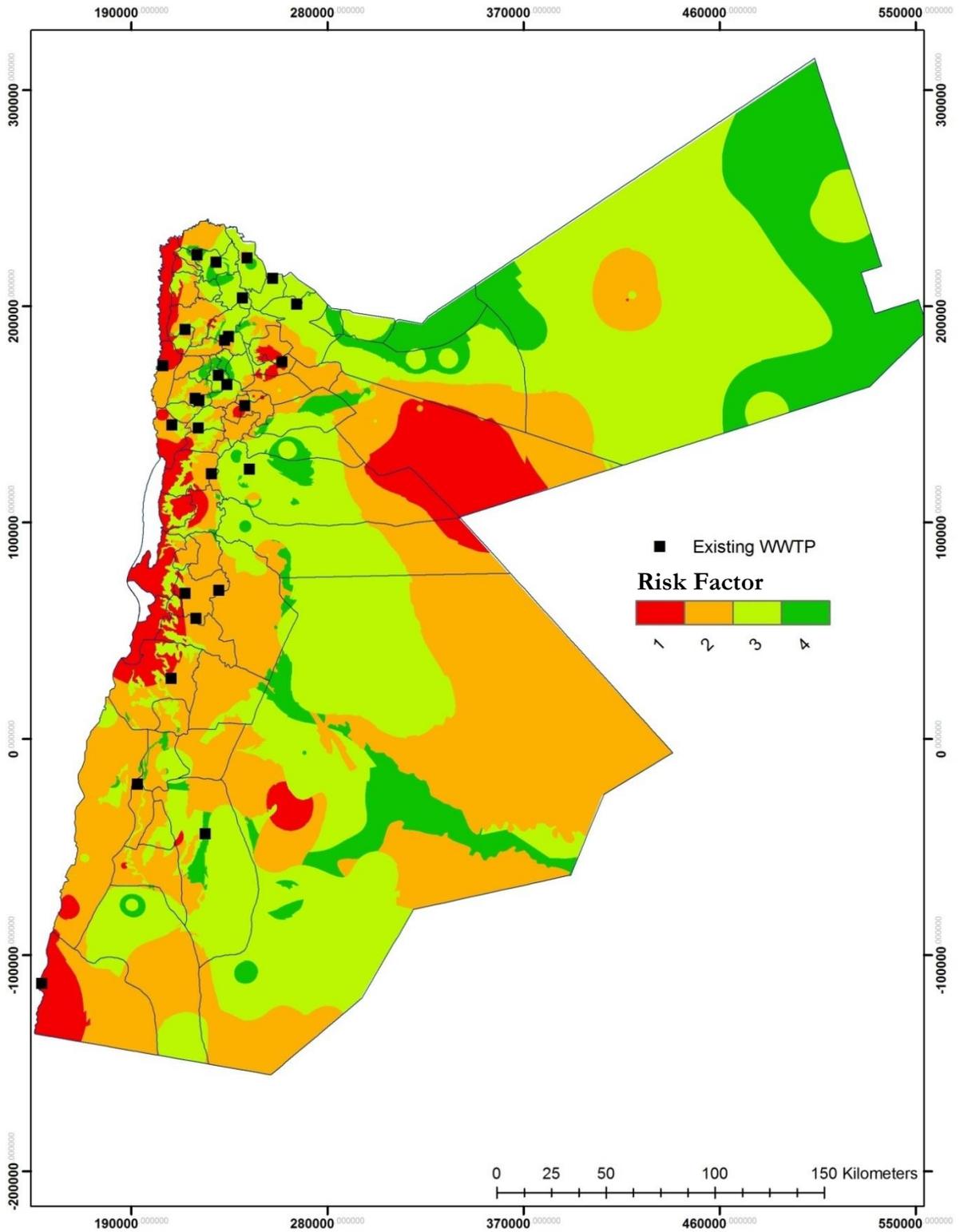


Figure V-10: Wastewater Treatment Priority Map.

# REFERENCES

No.	Governorate	Project	Report/Study	Date	By	Remarks
1	Amman	Water/Wastewater Infrastructure Project	Amman Wastewater Master Planning Report	2012	CDM-Smith	V1, V2
2	Amman, Zarqa	Amman-Zarqa Wastewater Master Plan	Amman-Zarqa Wastewater Master Plan	1997	Harza	V1, V2, V3, Env. Ass
3	Amman, Zarqa	Amman-Zarqa River Basin Area Wastewater Master Plan Update	Amman-Zarqa River Basin Area Wastewater Master Plan Update	2006	MWH	Report, Appendices
4	Zarqa	Zarqa Governorate Wastewater System Reinforcement and Expansion-MCC	Preparatory Works Technical Report	2010	MWH	
	Zarqa	Feasibility Study, Environmental and Social Impact Assessment and Detailed Designs and Bidding Documents for Zarqa Governorate Wastewater System Reinforcement and Expansion Project	Final Hydraulic Modeling & Master Plan Report	2010	MWH	V1, V2
5	Aqaba	Upgrade and Expansion of Aqaba Wastewater Facilities	Design Report	2002	MWH	
	Aqaba	Aqaba Wastewater Collection System Master Plan	Master Plan Report	2010	MWH	V1, V2
6	Karak	Karak Wastewater Project	Detailed Design Report	2010	Dorsch Consult	V1, V2
7	Karak	Wastewater Collection, Treatment and Effluent Reuse from Municipalities Of Mazar, Mu'ta, Adnaniyyeh And Adjacent Areas	Conceptual Report	2008	Engicon	
8	Ma'an	Water/Wastewater Infrastructure Project	Ma'an Water and Wastewater Master Plan	2013	CDM-Smith	V1
9	Tafilah	Water/Wastewater Infrastructure Project	Tafilah Water and Wastewater Master Plan	2013	CDM-Smith	V1, V2, V3
10	Irbid	Update of the Existing Feasibility Study, Concept and Detailed Design, Tendering and Supervision for Reuse of Treated Wastewater for Irrigation Purposes in the Northern Jordan Valley	Design Report WWTP Central Irbid	2012	GITEC	KfW funded

No.	Governorate	Project	Report/Study	Date	By	Remarks
11	Irbid	Update of the Existing Feasibility Study, Concept and Detailed Design, Tendering and Supervision for Reuse of Treated Wastewater for Irrigation Purposes in the Northern Jordan Valley	Design Report WWTP Wadi Arab	2012	GITEC	KfW funded
	Irbid	Sahel Horan Municipalities ww collection , treatment and reuse project	Final Design Report	2012	Orient, CEC, Doesch	
	Irbid	Birqish Wastewater Collection System	Final Design Report	2010	CEC	
12	Jerash	Design and study of collection sewer networks and house connection services and lift stations for JEARSH entrance and the adjacent areas Project	Preliminary Report, Final Design Report	2009	Orient	
13	Jerash	Water/Wastewater Infrastructure Project	Jerash Wastewater Master Plan	2012	CDM-Smith	V1
	Mafraq	Wastewater Network and Lifting stations for Manshiyyat Bani Hasan and Adjacent areas	Final Design Report	2011	ACEPO	
14	Northern Governorates	Update of the Existing Feasibility Study, Concept and Detailed Design, Tendering and Supervision for Reuse of Treated Wastewater for Irrigation Purposes in the Northern Jordan Valley	Feasibility Study Update	2011	GITEC	KfW funded
15	Balqa	Wastewater Treatment Feasibility Study Jordan	Final Report	2009	CH2MHILL	Hard Copy

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